# THE EFFECT OF INITIAL DEFLECTION ON THE STRESS DISTRIBUTION IN A PANEL OF PLATING OF A SHIP UNDER TENSILE LOAD

Wilfrido T. Freire Duenas
and
German Winkelmann De La Cruz

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# ON THE STRESS DISTRIBUTION IN A PANEL
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# ABSTRACT

## THE EFFECT OF INITIAL DEFLECTION ON THE STRESS DISTRIBUTION IN A PANEL OF PLATING OF A SHIP UNDER TENSILE LOAD

by

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Submitted to the Department of Naval Architecture and Marine Engineering on May 24, 1954, in partial fulfillment of the requirements for the degree of Naval Engineer

### OBJECT

The object of this investigation was to obtain quantitative data of the stress distribution in a panel of plating representing the plating of a vessel under tensile load, in order to establish a relation between the ratio of maximum stress to average stress and the ratio of initial deflection to plate thickness.

It is expected that a complete investigation of the effect of initial deflection on the stress distribution in a panel of plating will provide a technical criteria to specify the maximum allowable initial deflection to avoid excessive stress in the material.

### METHOD

Four specimens were made of 1/8" plate with welded stiffeners forming 3 panels of 18" x 6". The models were designed to be bolted to pulling members adapted to fit a 300,000 pound tensile testing machine. Roughly the initial deflection of the center panel of the models were: zero, 1/8", 3/16" and 1/4".

The samples were tested using the stress-coat technique to determine the direction of the principal stresses.

SR-4 strain gages type A-3 were installed in two rows, one at the center of the panel and the other near the transverse stiffener, at both sides of the plate.

The samples were tested by applying the load gradually, and the strains recorded at each interval of load.

Plots were made of the load versus strain for each strain

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gage. From these diagrams strains were obtained at loads of 20, 40, 60, 80 and 100 kips, and these values were plotted against the position of the strain gage on the plate. The mid-depth strain distribution was obtained by averaging the strains at each point on both sides of the plate.

From the strain distribution diagrams the maximum and minimum strain values were obtained, as well as the average strain in the plate, at each level of load. The ratio of maximum and minimum strain to average strain in the plate were thus obtained, and these values plotted against the ratio of initial deflection to plate thickness.

The strain distributions at 60 kips load were used to check the data, by comparing the integration of stress times cross sectional area with the corresponding load.

## RESULTS AND CONCLUSIONS

It was observed that when deflection exists the strain is not uniformly distributed. The maximum strains were found on the unstiffened face of the panel at about the quarter points. The minimum strains were found on the stiffened face, which is the convex face of the panel, at about the center of the panel. The mid-depth maximum strains were found close to the stiffeners.

The ratio maximum to average strain increases almost linearly, within the elastic region of the material, with the increase of the ratio initial deflection to plate thickness; the reverse is the case of the ratio minimum to average strain. All of these ratios approach to unity with the increase of load.

It should be noted that the maximum stresses were observed on the concave face, and that on the convex face the stress was so small that it became negative, or compressive stress, for initial deflection thickness ratio greater than one.

## RECOMMENDATIONS

1. Construction and testing of samples of different aspect ratio.
2. Construction and testing of samples with low depth of stiffeners welded at both sides of the plate, in order to obtain the neutral axis of the stiffeners in line with the neutral axis of the plate to eliminate bending moment effects.

Thesis Supervisor: JOHN HARVEY EVANS
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May 24, 1954

Secretary of the Faculty
Massachusetts Institute of Technology
Cambridge 39, Massachusetts

Dear Sir:

In accordance with the requirements for the degree of Naval Engineer, we submit herewith a thesis entitled, "The Effect of Initial Deflection on the Stress Distribution in a Panel of Plating of a Ship Under Tensile Load".

Respectfully yours,

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# I. INTRODUCTION

In the structural design of a vessel the hull is considered to work as a beam. The difference between the buoyancy distribution and the weight distribution causes a longitudinal bending moment.

It is standard practice to design the strength of the hull, by considering the vessel in two extreme conditions: floating on a wave with the same length of the vessel and with the crest at each end of the vessel, called "sagging condition", and with the crest admiship, called hogging condition. These two conditions are considered to be the most severe manners of loading.

Tests have been made for many years to prove that the hull works as a beam. The first extensive experiments were carried out on the 200 feet transversely framed British destroyer "Wolf" in 1903, and while in many respects setting the pattern for subsequent work, they left many questions unanswered principally because of the scanty strain data taken below the vessel's neutral axis. In 1930 two identical 310 feet transversely framed U.S. destroyers, the "Preston" and the "Bruce", were observed while being loaded in sagging and hogging respectively. Within the past three years another British destroyer, the 355 feet longitudinally framed "Albuera" was similarly loaded in hogging. All these vessles were of riveted construction and were loaded by means of being supported on piers in drydock as the water level and the internal weight distribution was varied. The "Preston", "Bruce", and "Albuera" were loaded to destruction when complete buckling of deck or bottom structure occurred. Except on the "Wolf", for which fore and aft strains only

were measured, multi-axial plain strains were determined enabling principal stresses in magnitude and direction to be calculed. In all cases, stress distribution was found to be in generally good agreement with the classical beam theory, even for extended ranges of loading.

During the past World War II, the emergency merchant fleet was built almost entirely by welding type of construction. Some of these ships were reported damaged by cracking of the hull structure. Investigations of these failures arrived to the following causes of failure:

(a) Stress concentration due to notch effect, being the notch introduced by poor design (corner of hatches, non-continuity of longitudinal members), or caused by poor welding (low penetration, inclusions, blows in the melted metal).

(b) Brittle fracture at low temperature.

These causes explained the failure of vessels that cracked due to notch effects, or that failed because the material had a high critical temperature, but failed to explain why well designed vessels and well constructed suffer cracks in summer when a sister ship is still in service.

A theory advanced to the authors by Professor J. H. Evans, of the Massachusetts Institute of Technology relates the variation in stress to the amount of initial bulge in the panel between stiffeners. If an initial bulge exists in a section of ship plating of a transversely framed vessel, and this section is loaded in tension, the part of the plating containing the bulge will be unable to assume its apportioned share of the load until the deflection is removed; the

section of the plating adjacent to the longitudinal stiffeners will therefore receive and maintain a disaproportionately high part of the load. It is conceivable that the high stresses developed could cause surface crackings, and subsequent failure.

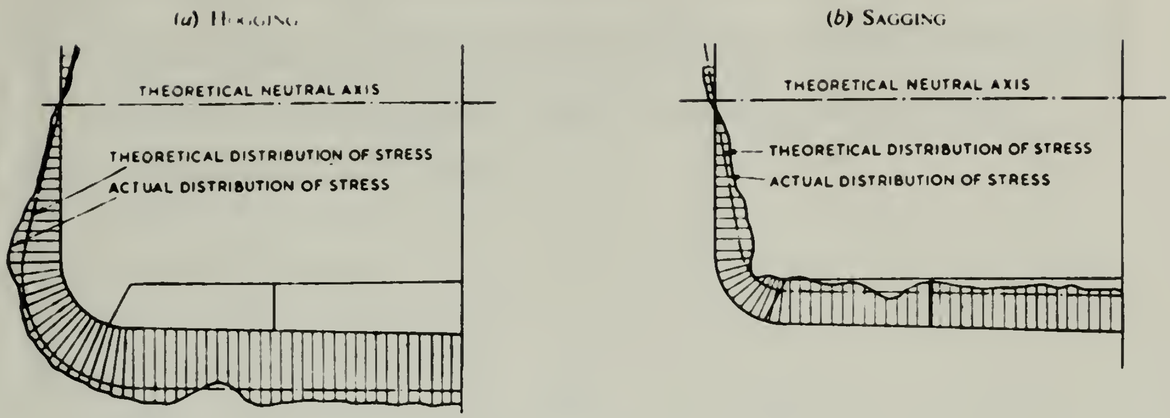
Several investigations have included observations which tend to substantiate the foregoing idea. The Admiralty Ship Welding Committee reported full scale tests on the British identical cargo ships "Ocean Vulcan" and "Clan Alpine", and on identical tankers "Neveritas" and "Newcombia"; one vessel in each pair was all riveted while the other was predominantly all welded. The findings of interest to this report are well summarized in Figure I. The stresses in way of the longitudinal stiffeners of the welded ships, for both hogging and sagging conditions, are much greater than the stresses clear of the stiffeners. This is not true for the case of riveted ships, and the difference could be laid to the minor accommodations in the riveted joints to suit the imposed loads.

What the allowable limit of unloaded plating unfairness should be is a question which needs answering for the benefit of all and the limit which insures against crack formation at the panel supports under the maximum coplanar loading anticipated is the ultimate criterion to be used in coming to a decision.

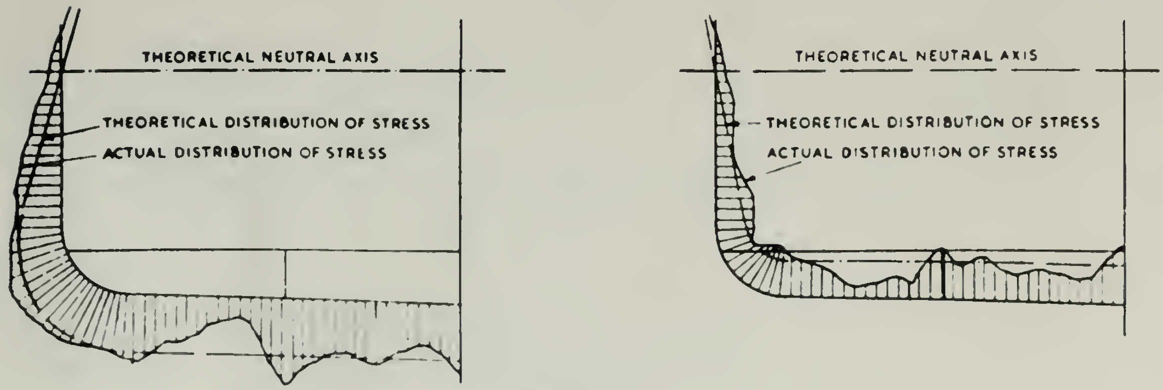
However, it seems that an excessive unloaded deflection may be attained not only during construction, but by growth under the lateral water pressure or the ship hogging and sagging loadings. For such increasing permanent set to take place under ship service conditions apparently some initial unloaded panel unfairness is also necessary.

FIGURE I

Distribution of longitudinal stresses for bottom shell plating near amidships for merchant vessels.


(a) Hogging
(b) Sagging
THEORETICAL NEUTRAL AXIS
THEORETICAL DISTRIBUTION OF STRESS
ACTUAL DISTRIBUTION OF STRESS
THEORETICAL NEUTRAL AXIS
THEORETICAL DISTRIBUTION OF STRESS
ACTUAL DISTRIBUTION OF STRESS

RIVETED SHIP

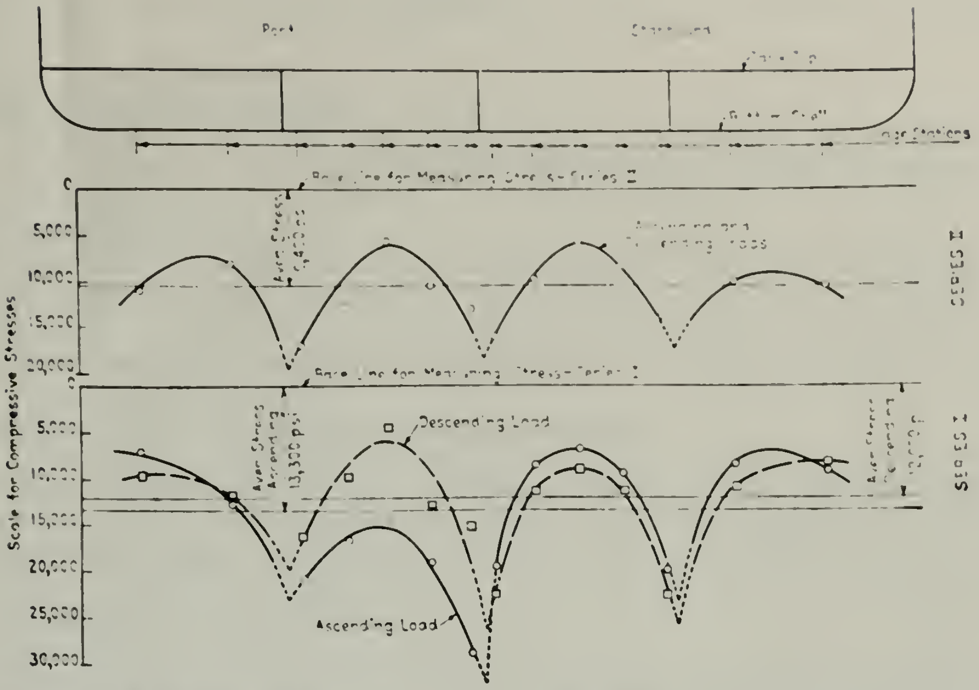

THEORETICAL NEUTRAL AXIS
THEORETICAL DISTRIBUTION OF STRESS
ACTUAL DISTRIBUTION OF STRESS
THEORETICAL NEUTRAL AXIS
THEORETICAL DISTRIBUTION OF STRESS
ACTUAL DISTRIBUTION OF STRESS

WELDED SHIP

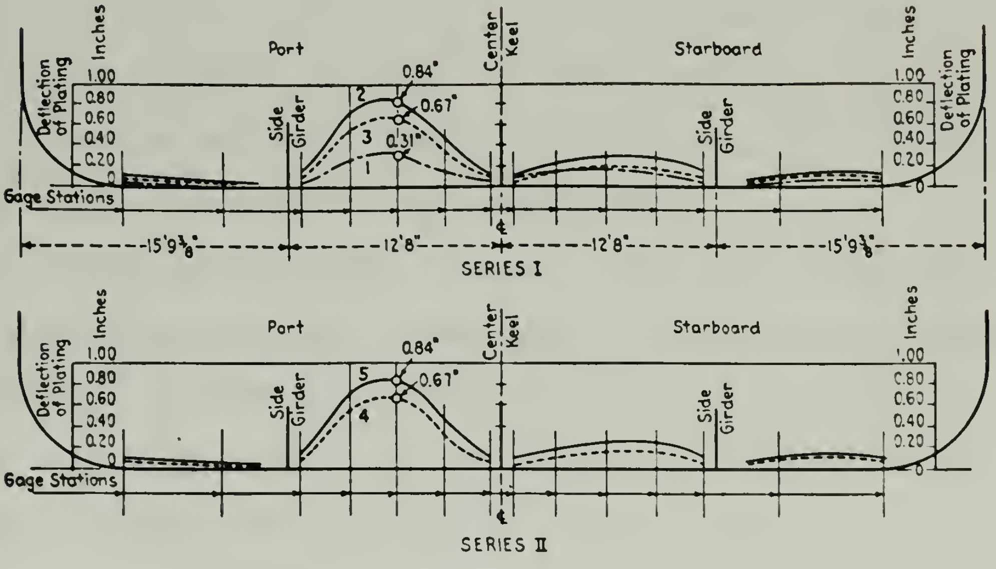
but its limiting value is presumably less than that which makes for sufficient peaking of stress in the fore and aft direction at the boundaries to cause the crack which may immediately or subsequently propagate under the proper conditions, probably including low temperature, or perhaps some transverse strain restrain offered by the framing. Figure II illustrate the case of increasing unfairness of the plating caused by the longitudinal bending moment, from observations made on experiment carried out on the "Philip Schuyler".

Unfairness under alterante tensile and compressive stress naturally compounds the evils.

FIGURE II



Longitudinal Membrane Stresses for Hog Moment of 134,000 Foot-Tons



1 Initial position of bottom plating
2 Position under first hogging moment of 134,000 ft. tons (hog 1)
3 Position on return to 20,000 ft. tons (inter-hog 2)
4 Position under 20,000 ft. tons (inter-hog A & inter-hog B)
5 Position under second hogging moment of 134,000 ft. tons (hog A)

Deflection Profile of Bottom Plating
Midway Between Two Frames Amidships

Bottom Plating Behavior on the PHILIP SCHUYLER

# II PROCEDURE

## 2.1 Design of the Test Section

The design of the test section was governed by the following practical considerations:

a) The load capacity and size of the available testing machines.

b) Cross sectional area of the test section to obtain proper stress values with the selected testing machine.

c) Linear dimensions of the specimen to fulfill the selected cross sectional area, considering the proportion of dimensions used in ship building practice.

d) Desirability of uniform stress distribution along the loading edges of the section to be tested.

With this considerations in mind the following was done. A testing machine of 300,000 pounds of rated load capacity was selected, which has a maximum destructive load of 225,000 pounds, one of the largest available machines in order to reduce scale effects.

In the transverse framing system used in naval architecture, the common aspect ratio is from 3 to 3.75; these values were obtained from the Rules of the American Bureau of Shipping. The aspect ratio 3 was selected, and a panel of 6" x 18", with a plate of 1/8" thickness was considered adequate. Stiffeners of 1/4" thickness plate, and of 2 1/2" depth were used, avoiding the use of profiles like "L" or "T" to facilitate the installation of the strain gages.

With the above dimensions we obtain a cross sectional area of the test section of 4.25 square inches, thus, the average stress with the

destructive loading capacity of the testing machine was 53,000 psi; this was considered satisfactory.

The test section with its dimensions is shown in figure III. It can be noted that three panels were used; the panel to be deflected was the central one, where the strain measurements were made, the other two panels being provided to obtain a more uniform stress distribution, and they were not deflected.

The neutral axis of the complete test section without initial deflection was calculated to be 0.449 inches from the unstiffened face of the plate. Considering that in way of the stiffeners the neutral axis shifts toward the mid-depth of the stiffeners, and that at the midway between stiffeners the neutral axis shifts toward the mid-thickness of the plate, there was a compromise to fulfill for the application of the load. The test sections were designed to be loaded in a plane through the mid-depth of the plate, and the scantlings of the stiffeners were decreased at the ends, as shown in figure III.

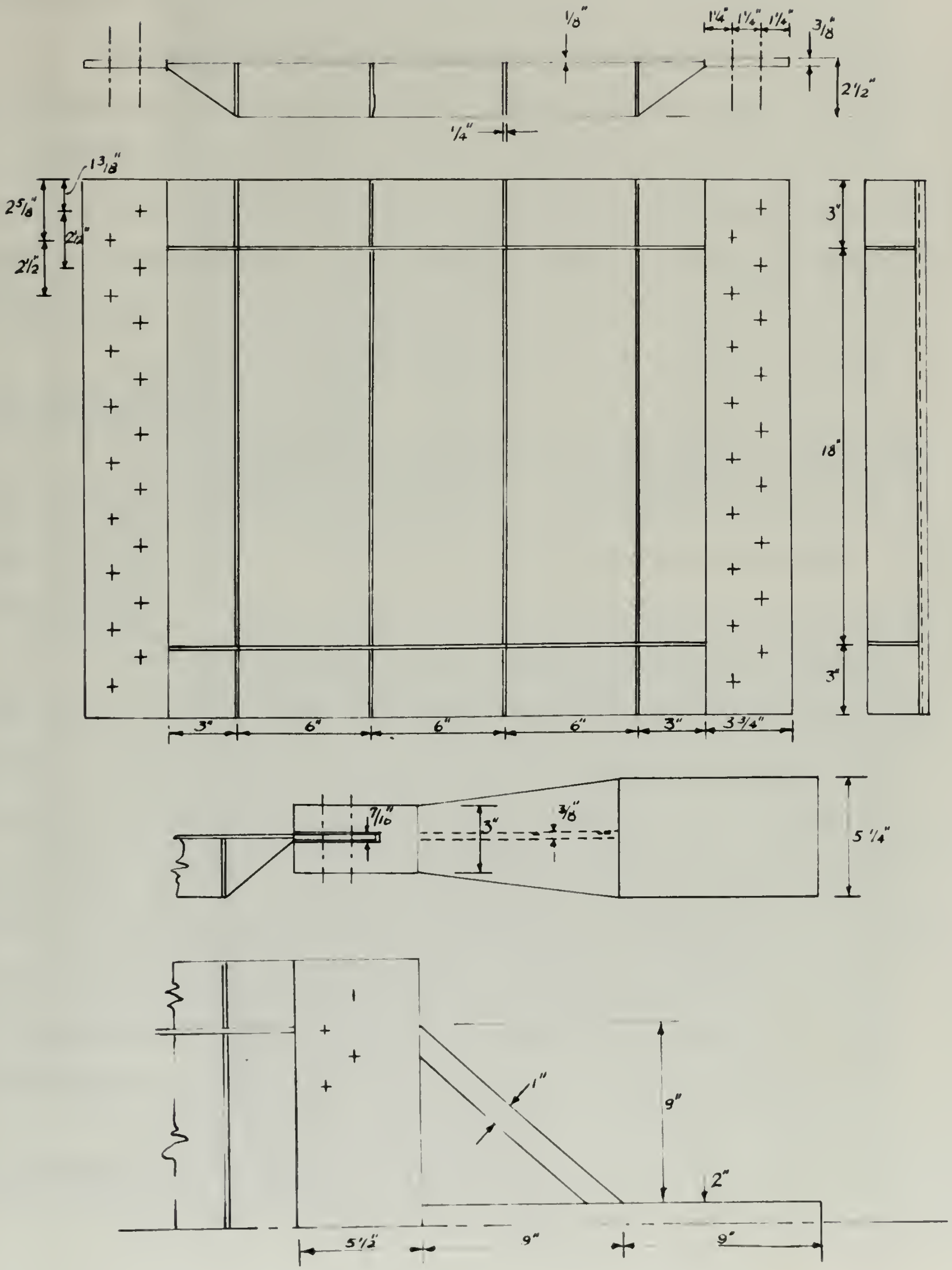
## 2.2 Design of the Pulling Members

The pulling members were designed to work under the yield point of the material at the maximum load capacity of the machine in order to minimize the deflection of the members and to obtain a fairly uniform stress distribution on the test section.

The linear dimensions obtained from the design calculations are shown in figure III. It may be estimated that the weight of each pulling member was about 250 pounds, and their cost much higher than that of the test section; therefore, it was considered desirable to have detachable

FIGURE III

TEST SECTION AND PULLING MEMBER



pulling members instead of having them welded to the test sections, in order to facilitate the handling of the equipment and to reduce the initial cost.

The test section was attached to the pulling members by means of 16 bolts of 1/2" diameter, and the strength of this joint considered as a riveted joint was greater than the strength of the test section; it should be noted that the thickness of the plate is increased at the bolted joint in order to obtain greater strength at the joint than at the test section.

## 2.3 Fabrication

The test sections and pulling members were made at "Saul Avery Steel Company", Cambridge, Massachusetts. The material used was commercial mild steel. The process of fabrication was arc welding. A heat treatment for stress relief was used at the end of the fabrication.

The test sections with zero nominal deflection and with 1/8" nominal deflection received the initial deflection in the central panel during the fabrication by effect of the welding of the stiffeners. The test section with 3/16" nominal deflection was hammered to increase the bulge caused by welding to the desired amount of deformation. The test section with 1/4" nominal deflection received the deflection of the central panel by lateral pressure using a compression testing machine of the Laboratory of Testing Materials at the Massachusetts Institute of Technology, with the aid of a piece of wood to avoid identations.

## 2.4 Measurement of the Initial Deflections

The initial deflection was measured with a dial gage graduated in

thousandths of an inch, mounted in a metal frame as shown in Figure IV. The frame was mounted in such a way that zero readings were obtained at 3 corners of the panel.

Measurements were made at intervals of 1/2 inch along parallel lines spaced 1/2 inch apart. Observed deflections are recorded in Table I in Appendix A.

The initial deflection data was plotted on cross-section paper, and contours of constant deflection were drawn, as shown in the "Contour Map of Initial Deflection", Figures V, VI, VII, and VIII.

To obtain the initial deflection of each test section, the following procedure was used:

a) The arithmetical mean averages of readings taken along the long borders of the panel, within the central 10 inches, were first computed.

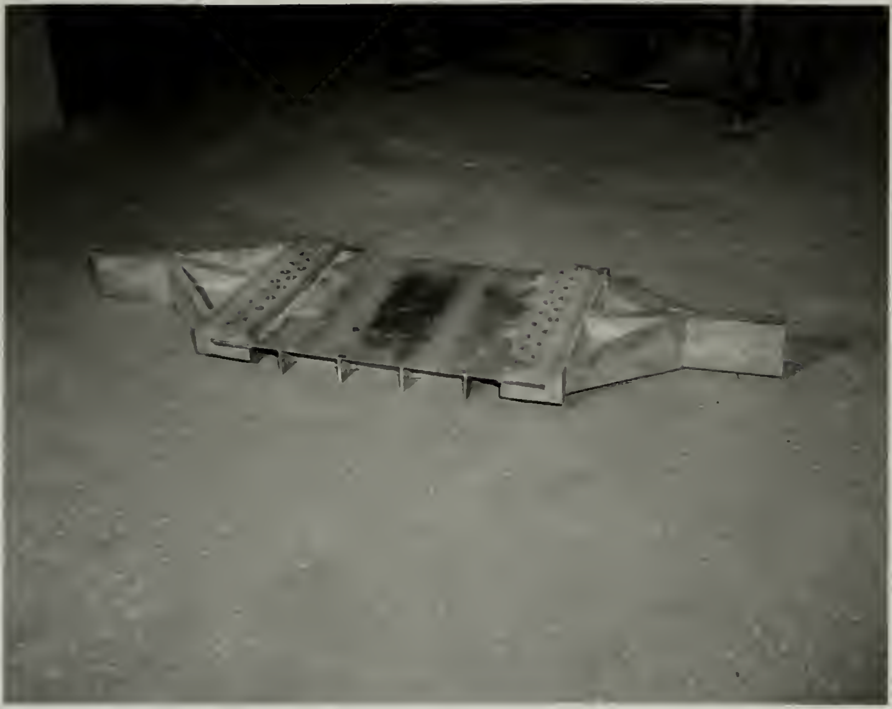
b) Next, the arithmetical mean average of readings taken along the transverse centerline of the panel were computed, within the central 10 inches, which is the section that showed the maximum deflection.

c) Finally, the difference between half the sum of the border arithmetical mean values and the center line arithmetical mean value gave the resultant average deflection of the panel. This calculation is shown on Table V in the Appendix C.

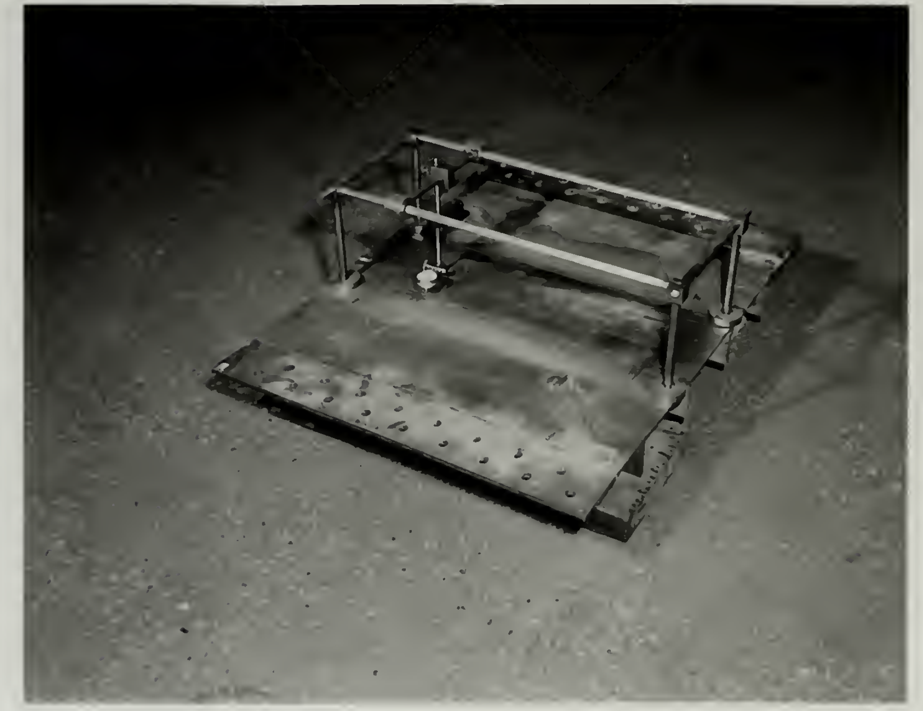
## 2.5 Stress-Coat Tests

The surfaces of the center panel of each test section were cleaned and polished with emery cloth. Next the surfaces were sprayed with precoat

FIGURE IV



Specimen

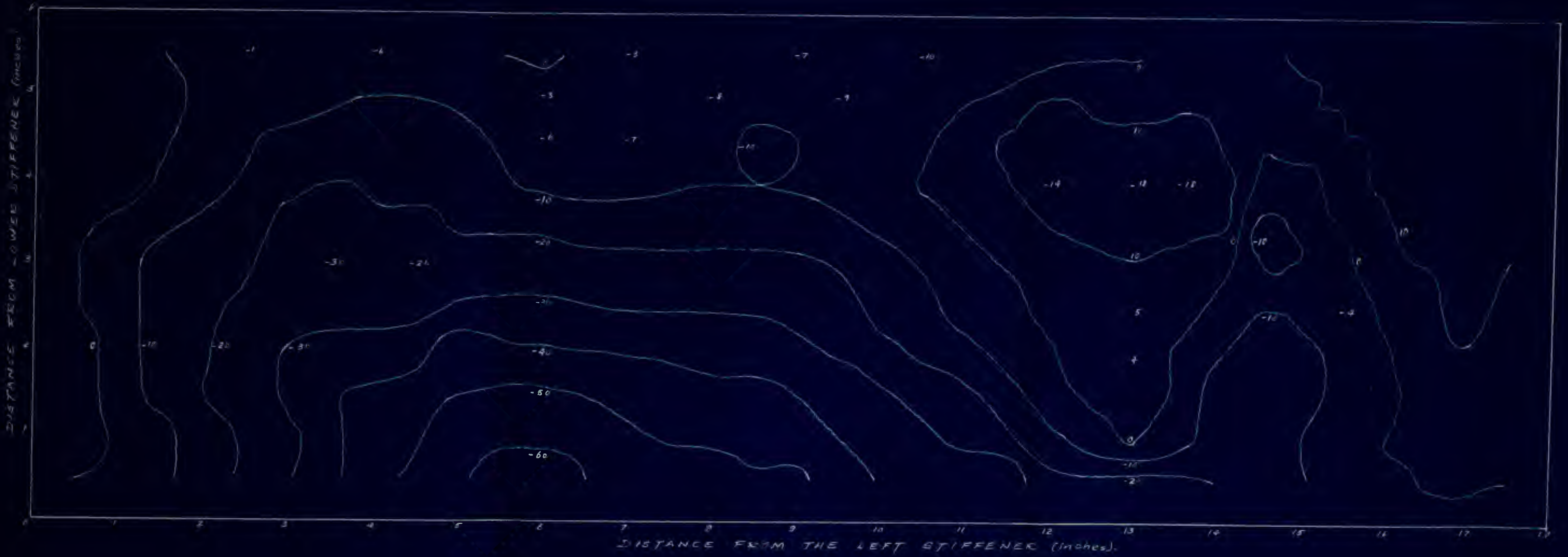


Measurement Device of Initial Deflection

# CONTOUR MAP OF INITIAL DEFLECTIONS

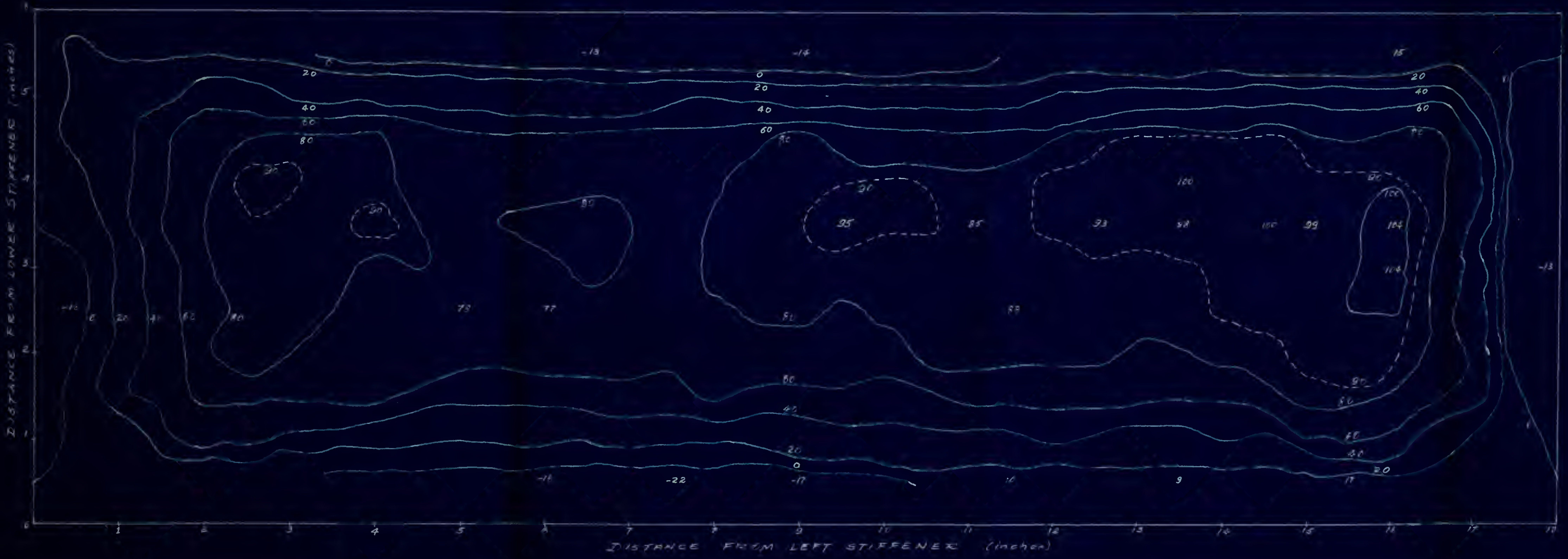
NOMINAL DEFLECTION ZERO

PANEL CONCAVE ON UNSTIFFENED SIDE
MEASUREMENTS IN THOUSANDS OF AN INCH



## CONTOUR MAP OF INITIAL DEFLECTIONS

NOMINAL DEFLECTION 1/8 INCH
PANEL CONCAVE ON UNSTIFFENED SIDE
MEASUREMENTS IN THOUSANDS OF AN INCH

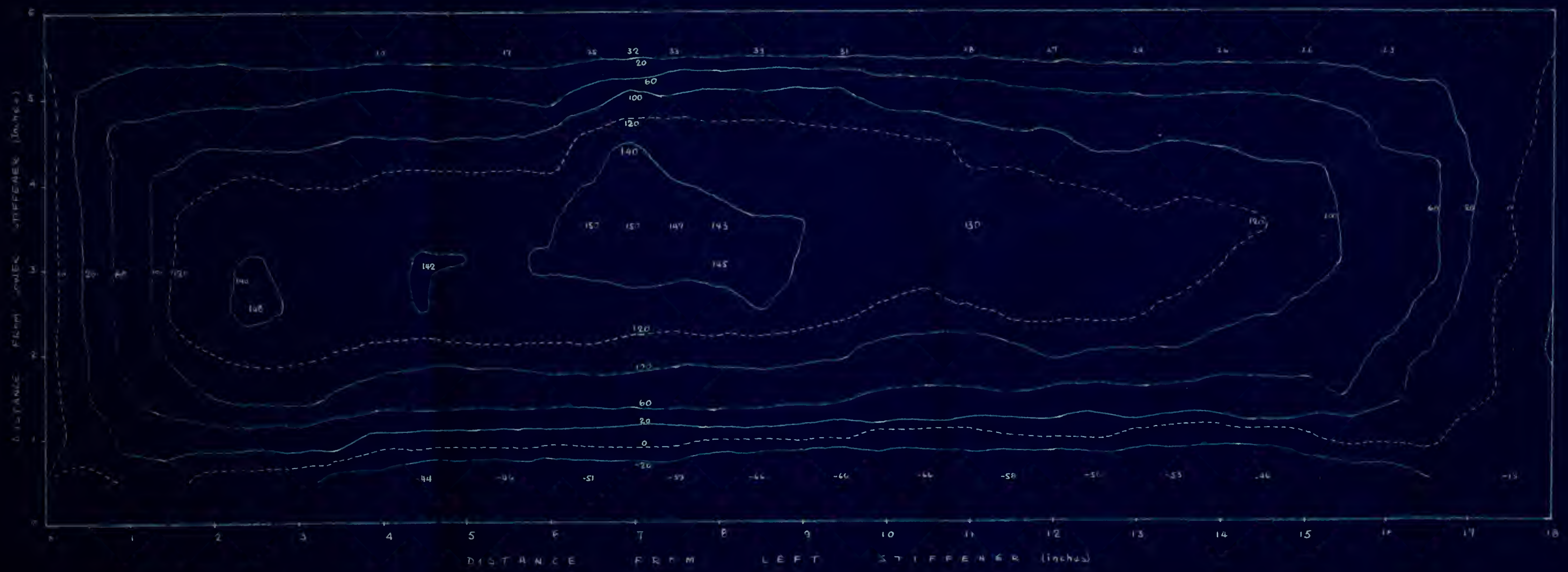


## CONTOUR MAP OF INITIAL DEFLECTIONS

NOMINAL DEFLECTION 3/16 INCH

PANEL CONCAVE ON UNSTIFFENED SIDE

MEASUREMENTS IN THOUSANDS OF AN INCH

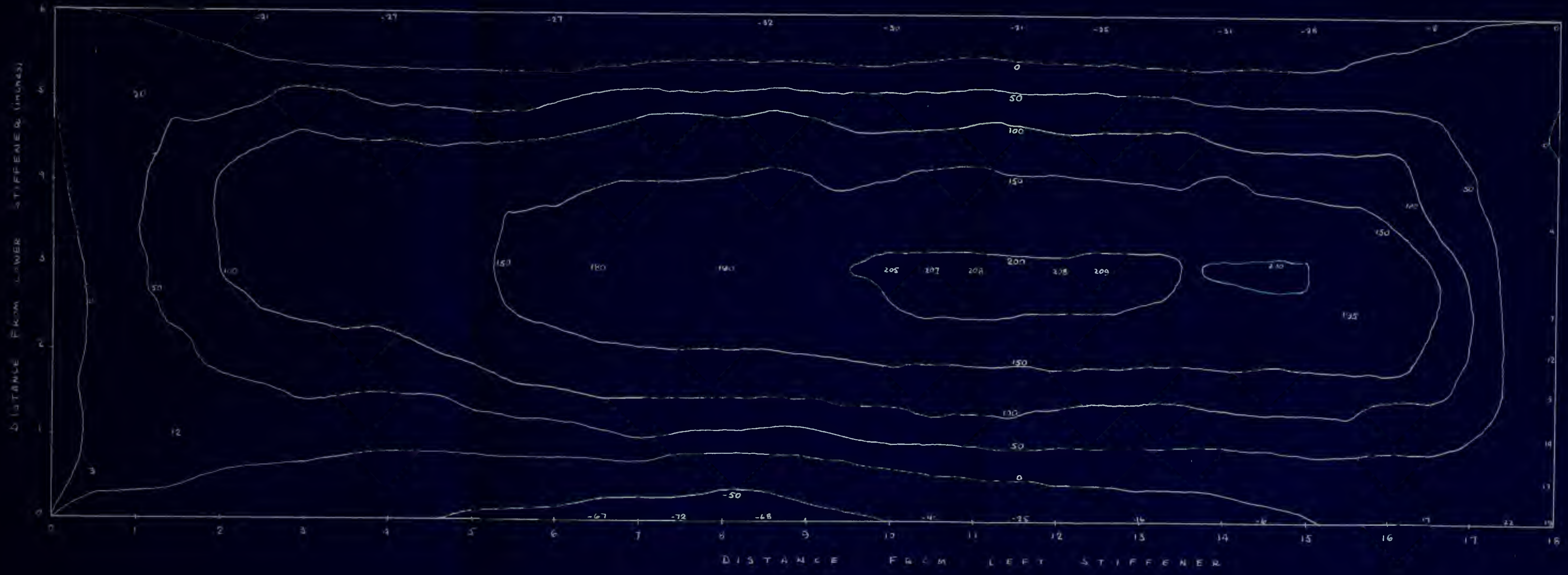


# CONTOUR MAP OF INITIAL DEFLECTIONS

NOMINAL DEFLECTION 1/4 INCH

PANEL CONCAVE ON UNSTIFFENED SIDE.

MEASUREMENTS IN THOUSANDS OF AN INCH.



in order to obtain a smooth surface. Then the stress-coat was applied. The precoat and the Strain Indicating Coating ST-1208 were manufactured by "Magnaflux Corporation", Chicago 31, Illinois.

The type of stress-coat selected was determined by the weather conditions, since temperature and humidity changes may cause cracking of the stress coat. The drying period of the stress-coat was 24 hours. In every test the weather condition did not change from the time of application of the stress coat to the time at which the test was performed.

The specimens were loaded to 80,000 pounds in order to obtain a complete crack pattern of the stress-coat. The crack pattern appeared only on the unstiffened side of the panel: no cracks were observed on the other side.

An attempt to make the crack pattern stand out by using dye-etching failed because the stress-coat was dissolved by the dye and the pattern disappeared.

In order to obtain a record of the crack pattern, it was necessary to mark the cracks with ink or pencil on the stress-coat itself. The next step was to transfer the delineated pattern to transparent paper. The "Pattern of Cracks in Stress Coat", are shown in Figures IX, X, XI, and XII.

The strain gages were aligned with the direction of the principal stresses, which is perpendicular to the direction of the cracks. It was considered that the strain gages on the stiffened side of the plate, where no crack pattern was formed, should be oriented in the same direction as the strain gages on the unstiffened side of the plate, because the direction

PATTERN OF CRACKS IN STRESS-COAT

ZSE(in) NOMINAL DEFLECTION PANEL

# PATTERN OF CRACKS IN STRESS-COAT

1/8 in NOMINAL DEFLECTION PANEL

## PATTERN OF CRACKS IN STRESS-COAT

$^3/_{16}$ in. NOMINAL DEFLECTION PANEL

## PATTERN OF CRACKS IN STRESS-COAT

1/4 IN. NOMINAL DEFLECTION PANEL

of the principal stresses would not change through the small thickness of the plate.

It should be noted that the cracks of the stress-coat were not produced at low level of load, but that they started to appear for loads above 60,000 pounds. Therefore, the orientation of the strain gages was governed by the direction of the principal stresses at high loads. It it believed that the direction of the principal stresses changed with the load. Because the magnitude of the deflection probably changed with the load; therefore, the measured strains at loads other than that which caused the cracks are not the true values of the principal strains.

Nevertheless, the strains measured by the strain gages located in the transverse centerline of the panel are undoubtly principal strains; since by symmetry, the principal strains should be oriented in the direction of the applied load, and the fact that the observed cracks are perpendicular to the transverse centerline on all specimens supports this conclusion. This consideration is emphasized to validate the conclusions of the experiment.

## 2.6 Application of Strain Gages

SR-4 Strain Gages type A-3 manufactured by "The Baldwin Lima-Hamilton Corporation", Philadelphia 42, Pennsylvania, were used. They were applied using SR-4 Pre-Coat and Cement, following the manufacturer's instructions using 64 Strain Gages per test section.

The locations considered ideal for the strain gages to obtain the curve of strain distribution is shown in Figures IX and through XII, but due to some small irregularities in the surface of the plate some of the

strain gages where applied in a slightly different location as indicated by Table II in the Appendix A. "Front Face" indicates the unstiffened side of the plate, and "Back Face" the stiffened one.

After the strain gages were applied and the cement had dried for 24 hours, the gages were electrically tested for continuity and insulation from the plate; the minimum insulation measured was 25 megohms, which is far above the required insulation of 5 megohms. Figure XIII is an illustration of a test specimen with the strain gages in place.

## 2.7 Strain Measurement

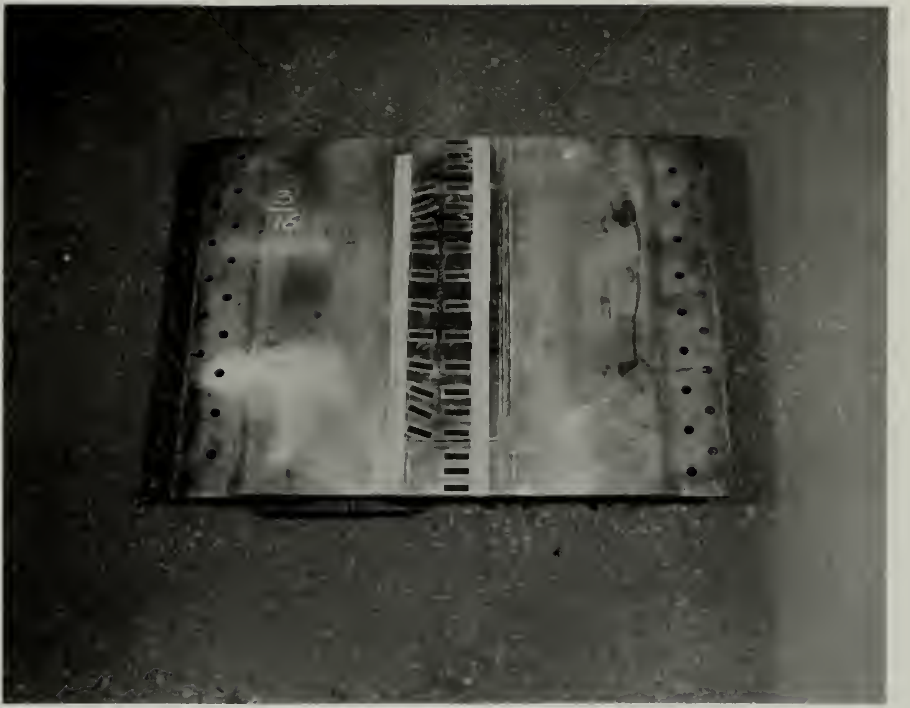
The testing machine used to load the specimens in tension was a "Southwark-Emery" hydraulic type, MIT serial 105. The control panel of this machine and the set-up of the equipment is shown in Figure XIV.

The strain gages were connected between ground and a switch-board formed by knife switches. Through the switch-board, the strain gages were connected to an SR-4 Strain Indicator, type L, serial H80797, manufactured by Baldwin-Southwark.

An initial load of 20,000 pounds was used to line-up the specimen in the testing machine, and then the load was reduced to zero to obtain the strain reading at zero load. Next the load was applied gradually, and the strains recorded at each level of load, as indicated in Table III in the Appendix A.

It should be noted that during the application of the load to measure the strains, some slip of the pulling members at the jaws of the testing machine was noticed, and this fact somewhat invalidated the

FIGURE XIII



Specimen with Strain Gages

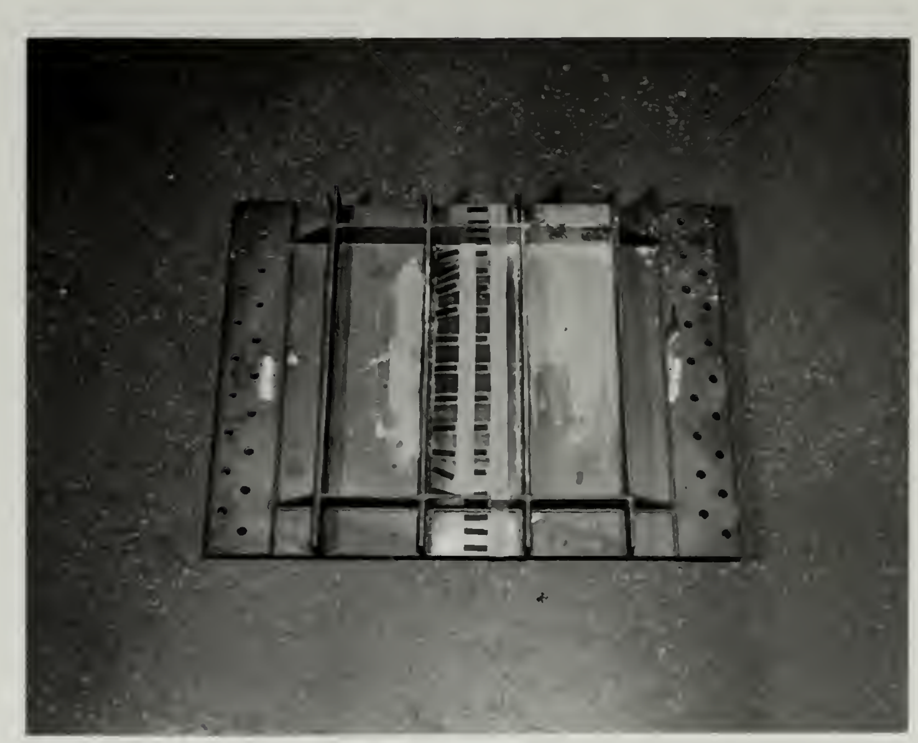
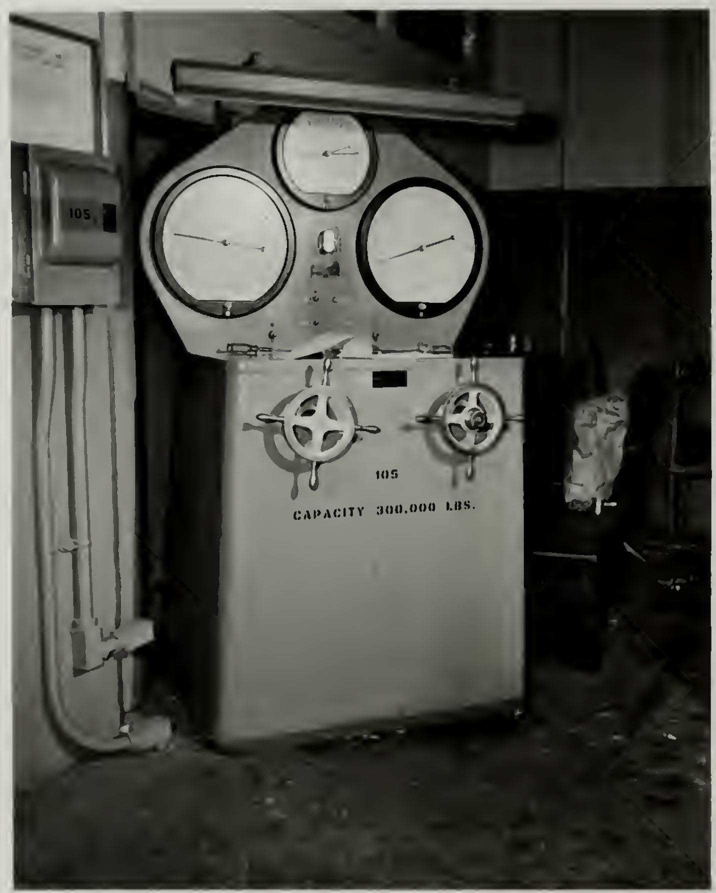
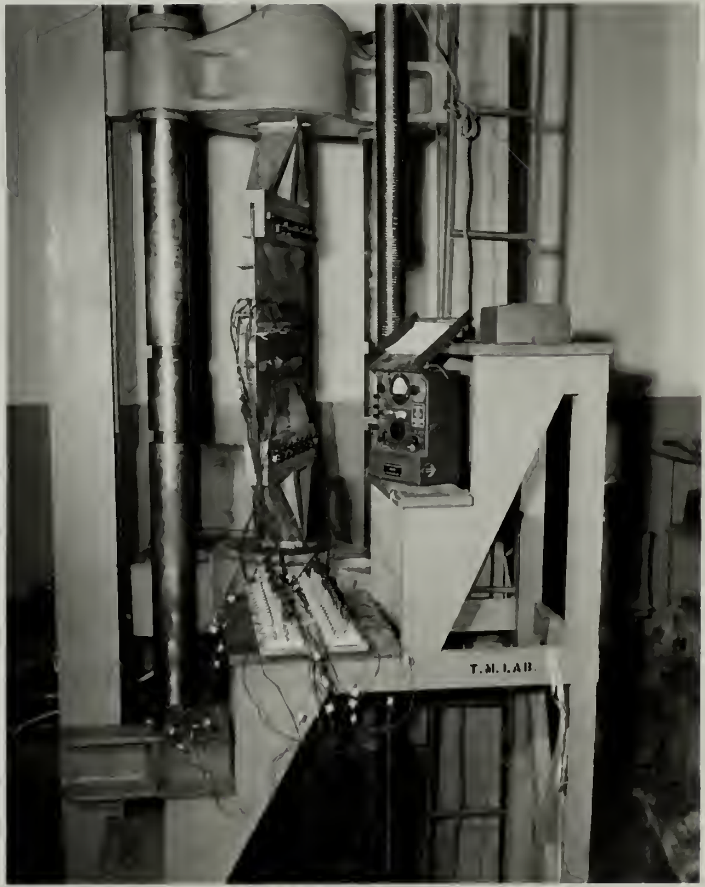


FIGURE XIV



Hydraulic Testing Machine
Control Panel



Set-up of the Equipment

strain reading at zero load, because of a probable change in the line-up of the specimen. This effect was particularly noticeable when the plate with 3/16" nominal deflection was tested.

## 2.8 Strain-Load Curves

The recorded strains were plotted against the applied load to check the correctness of the readings, as shown in Figures XV through XLIII. These curves represent the graphical average relation of strain to load at each strain gage position.

## 2.9 Strain Distribution Curves

From the Strain-Load curves, the strain at each strain gage was obtained for five levels of load, as recorded in Table IV in Appendix B. These strains were plotted against the positions of the strain gages to obtain the strain distribution curves at different levels of load for both the front face and the back face of the plate. The arithmetical mean average between both faces gave the strain values at the mid-depth of the panel. These values were also plotted against the position of the strain gages to obtain the strain distribution at the mid-depth of the plate. The strain distribution curves are shown in Figures XLIV through LVI.

## 2.10 Strain-Deflection Relationship

The arithmetical mean average of the strain distribution curve at the mid-depth for each specimen was taken as the average strain in the plate. This value is different from the strain that would be obtained by dividing the load by the product of the cross-sectional area times the modulus of elasticity of the material, assuming that the stiffeners shared the load.

FIGURE XV

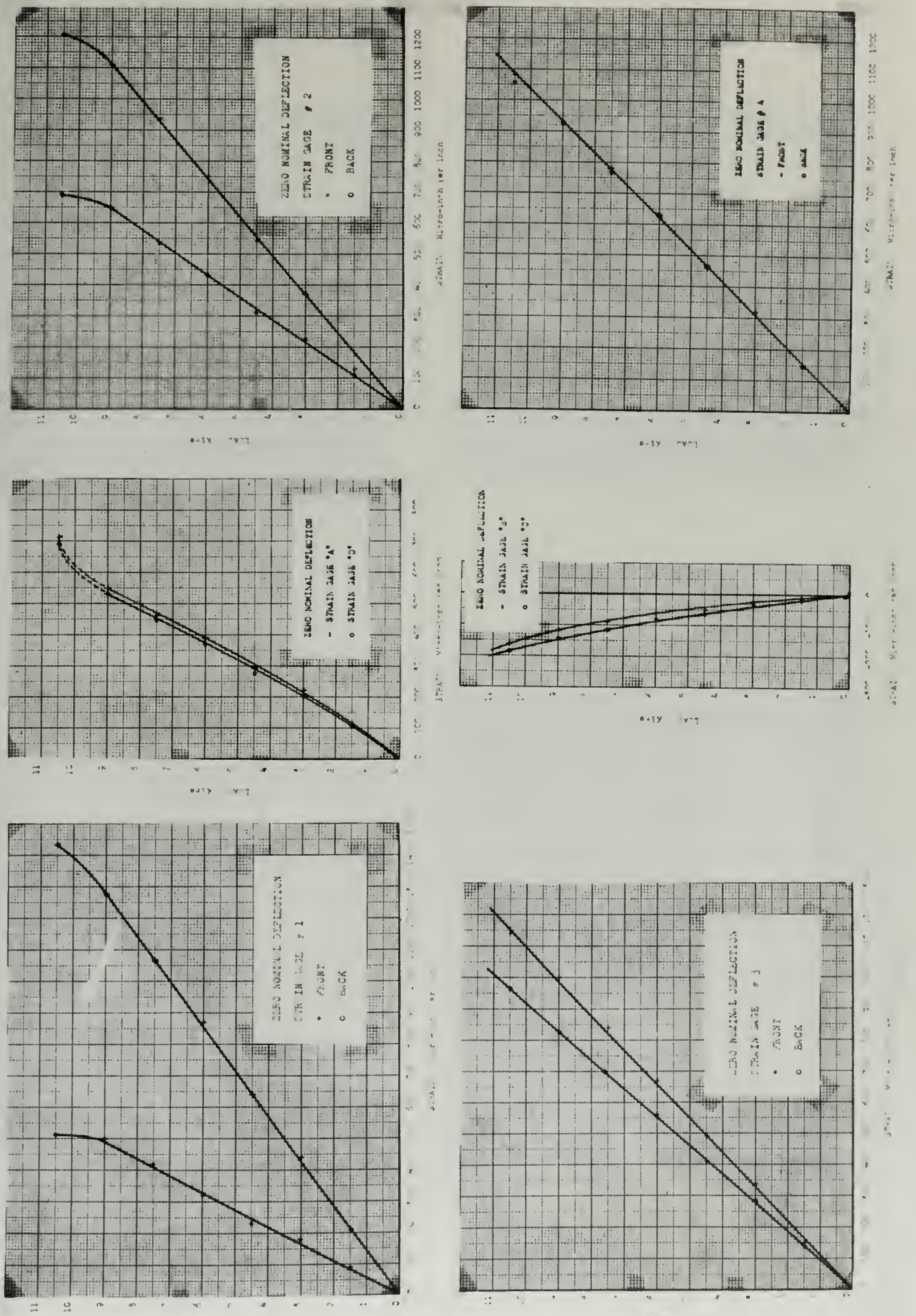

ZERO NOMINAL DEFLECTION
STRAIN GAGE # 2
• FRONT
○ BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 4
• FRONT
○ BACK
ZERO NOMINAL DEFLECTION
• STRAIN GAGE "A"
○ STRAIN GAGE "D"
ZERO NOMINAL DEFLECTION
• STRAIN GAGE "B"
○ STRAIN GAGE "C"
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 1
• FRONT
○ BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 3
• FRONT
○ BACK
STRAIN Micro-inch per Inch
LOAD Kips
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1
2
3
4
5
6
7
8
9
10
11

FIGURE XVI

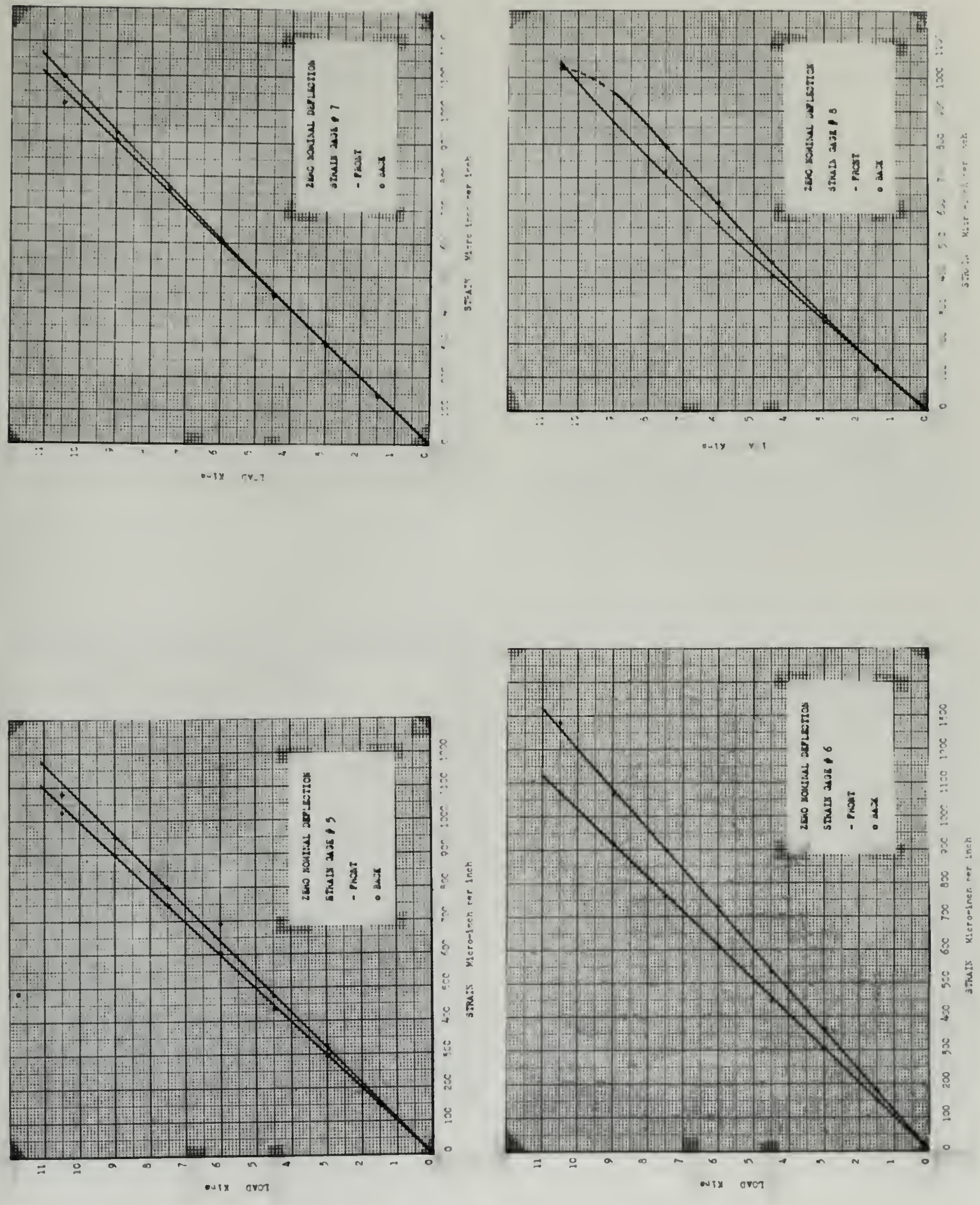

ZERO NOMINAL DEFLECTION
STRAIN GAGE # 7
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 8
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 5
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 6
- FRONT
o BACK
STRAIN Micro-inch per inch
LOAD Kips
0
1
2
3
4
5
6
7
8
9
10
11
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300

FIGURE XVII

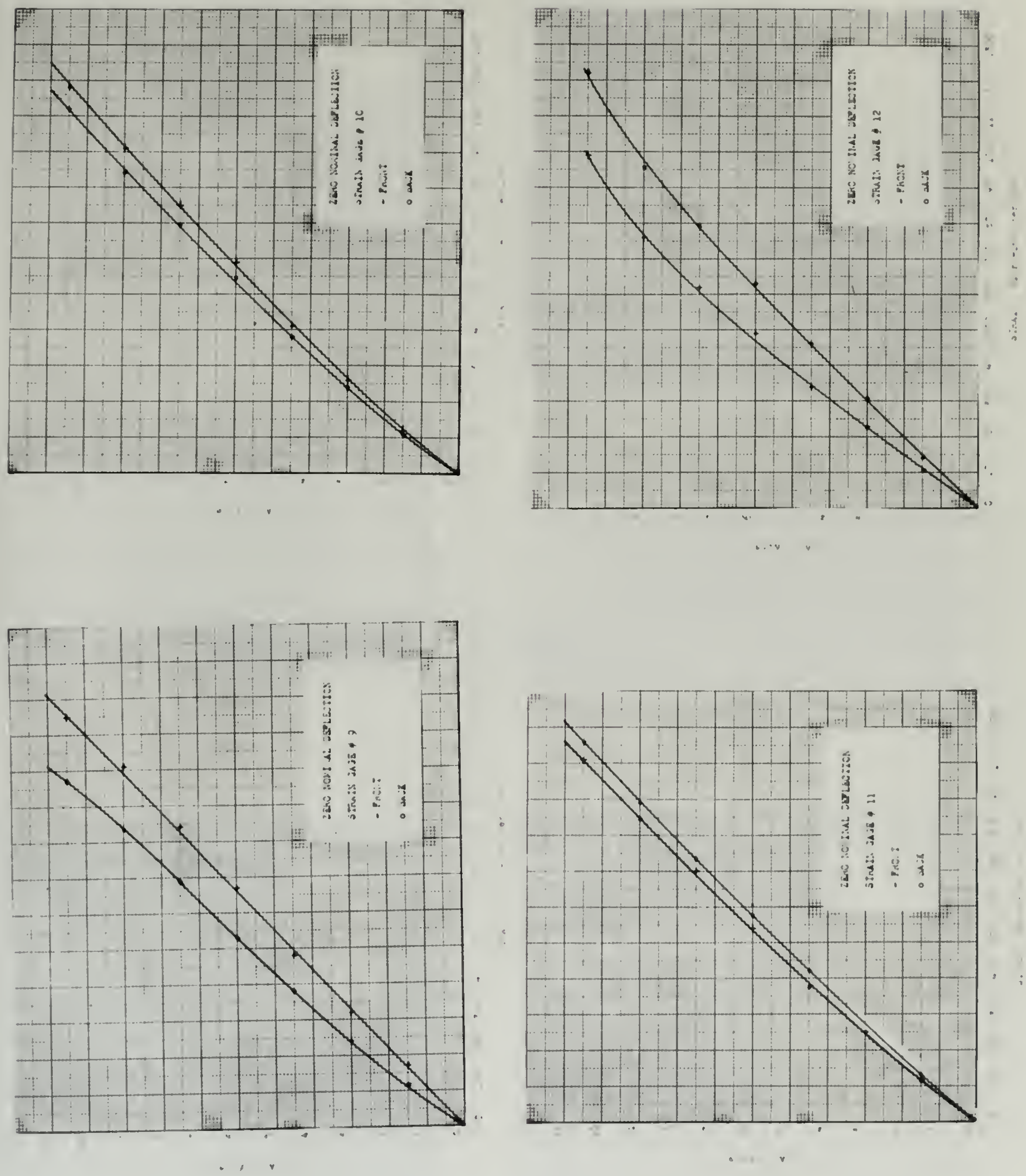
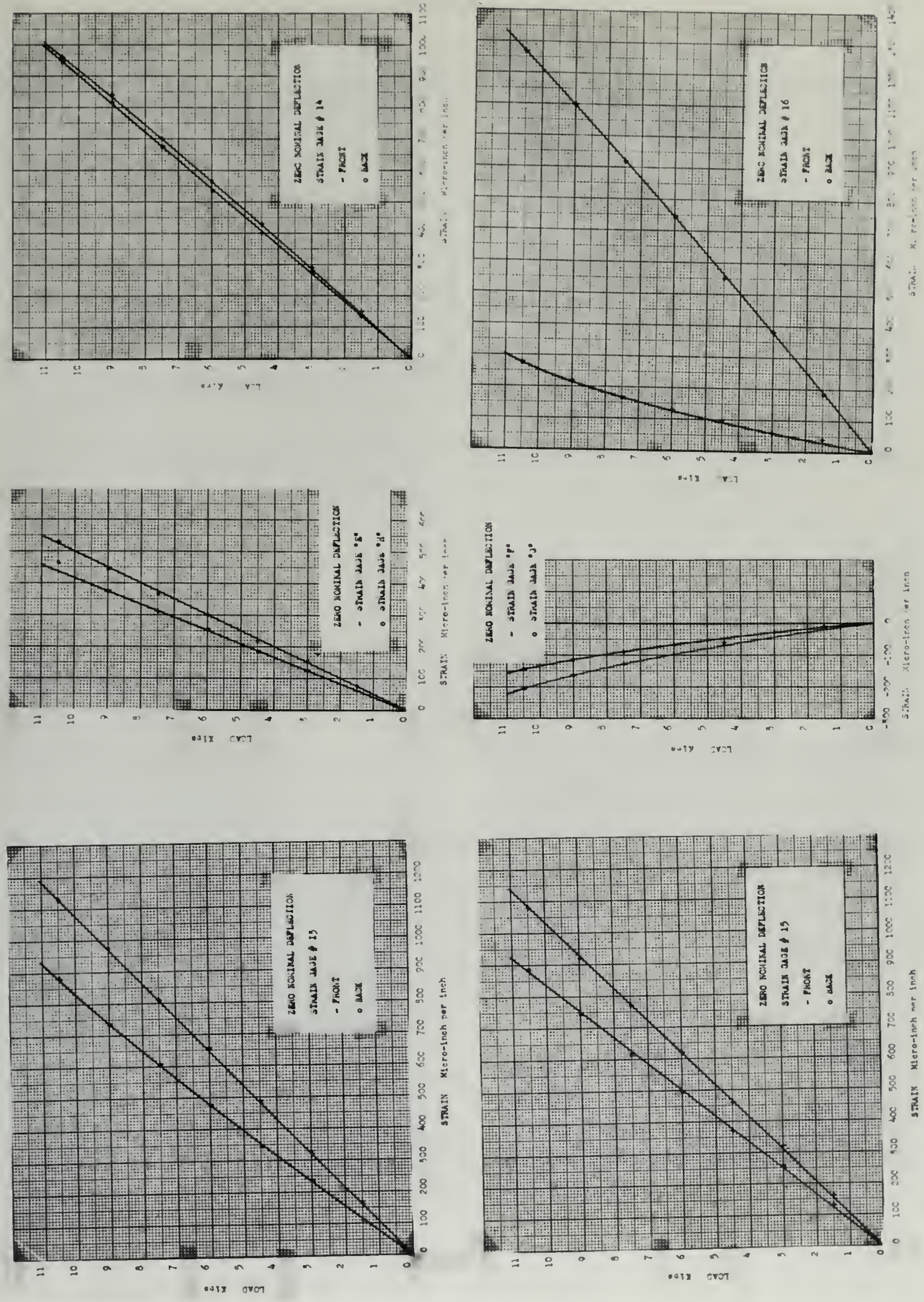
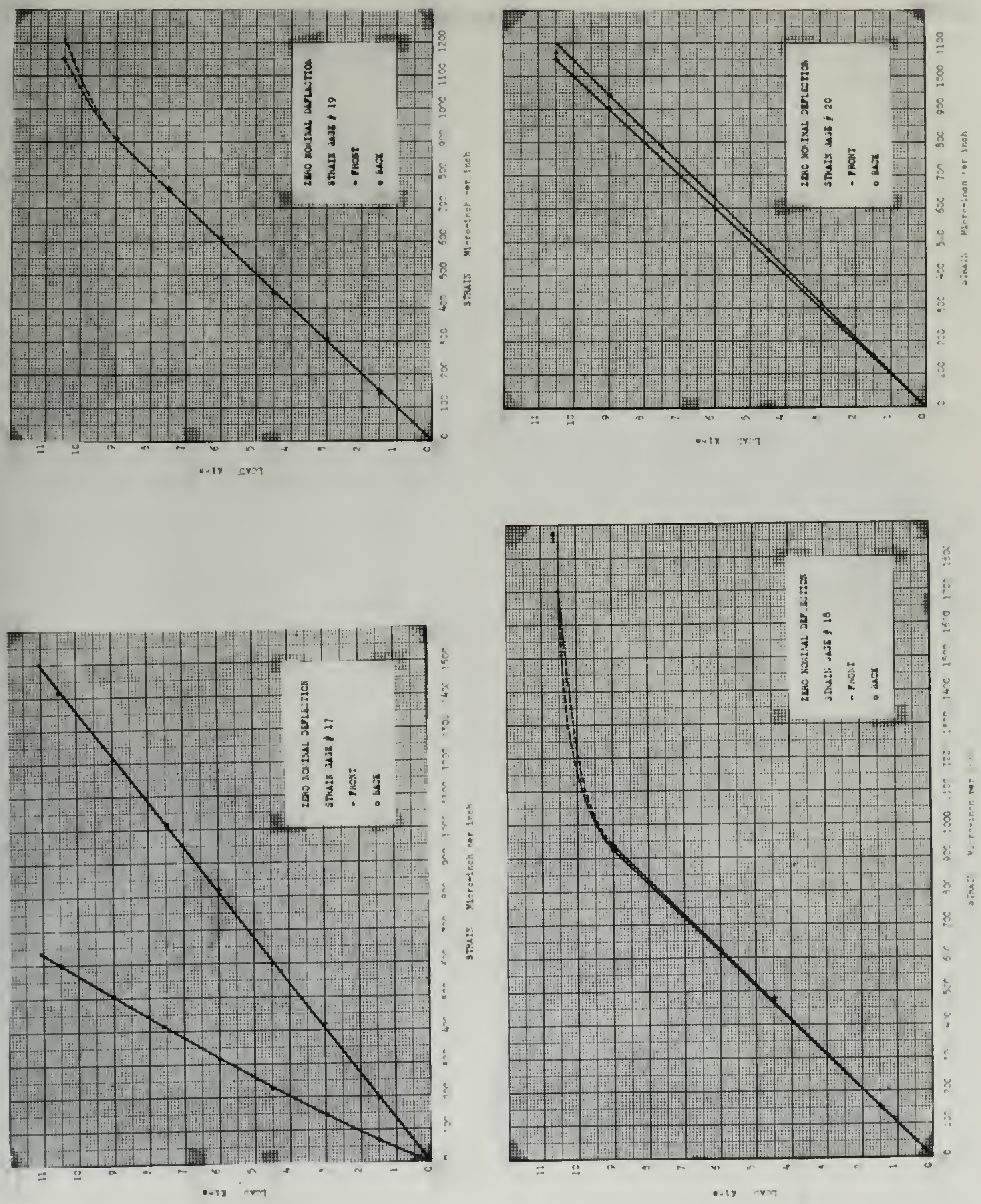

ZERO NOMINAL DEFLECTION
STRAIN GAGE # 10
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 12
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 9
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 11
- FRONT
o BACK

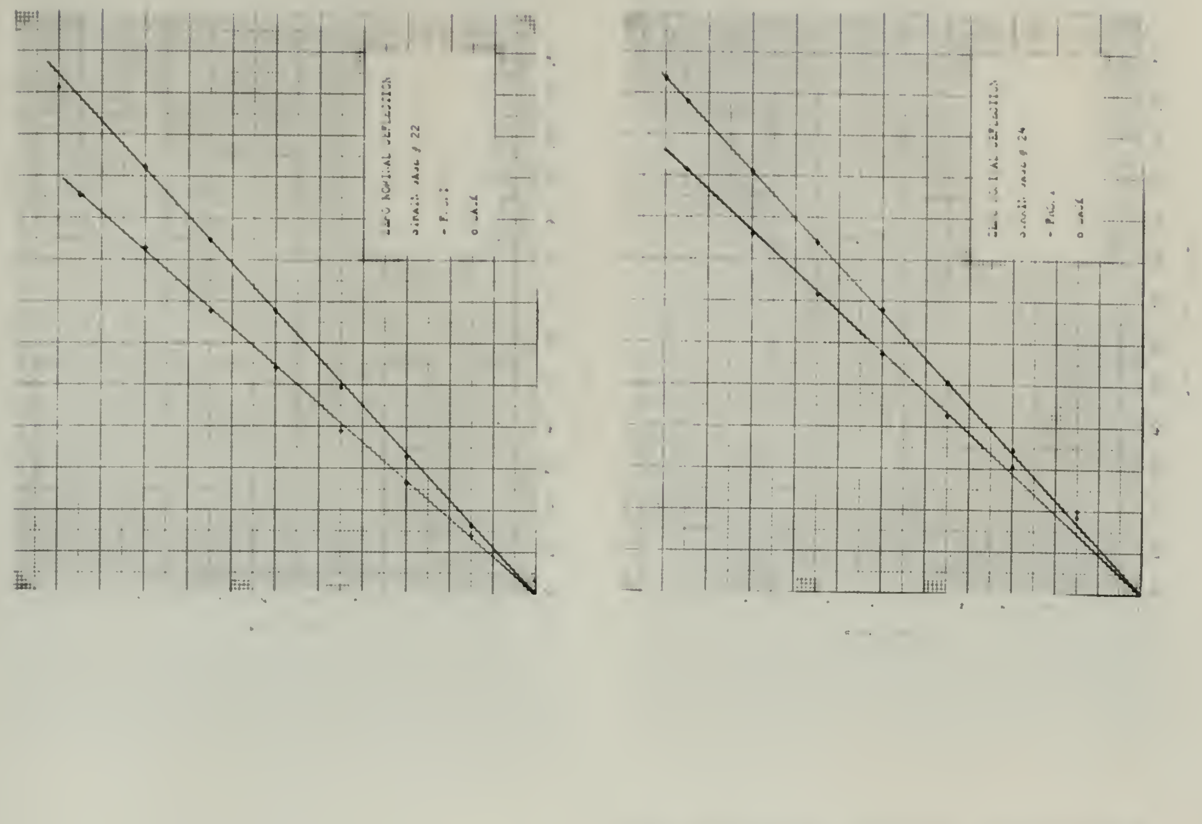
FIGURE XVIII



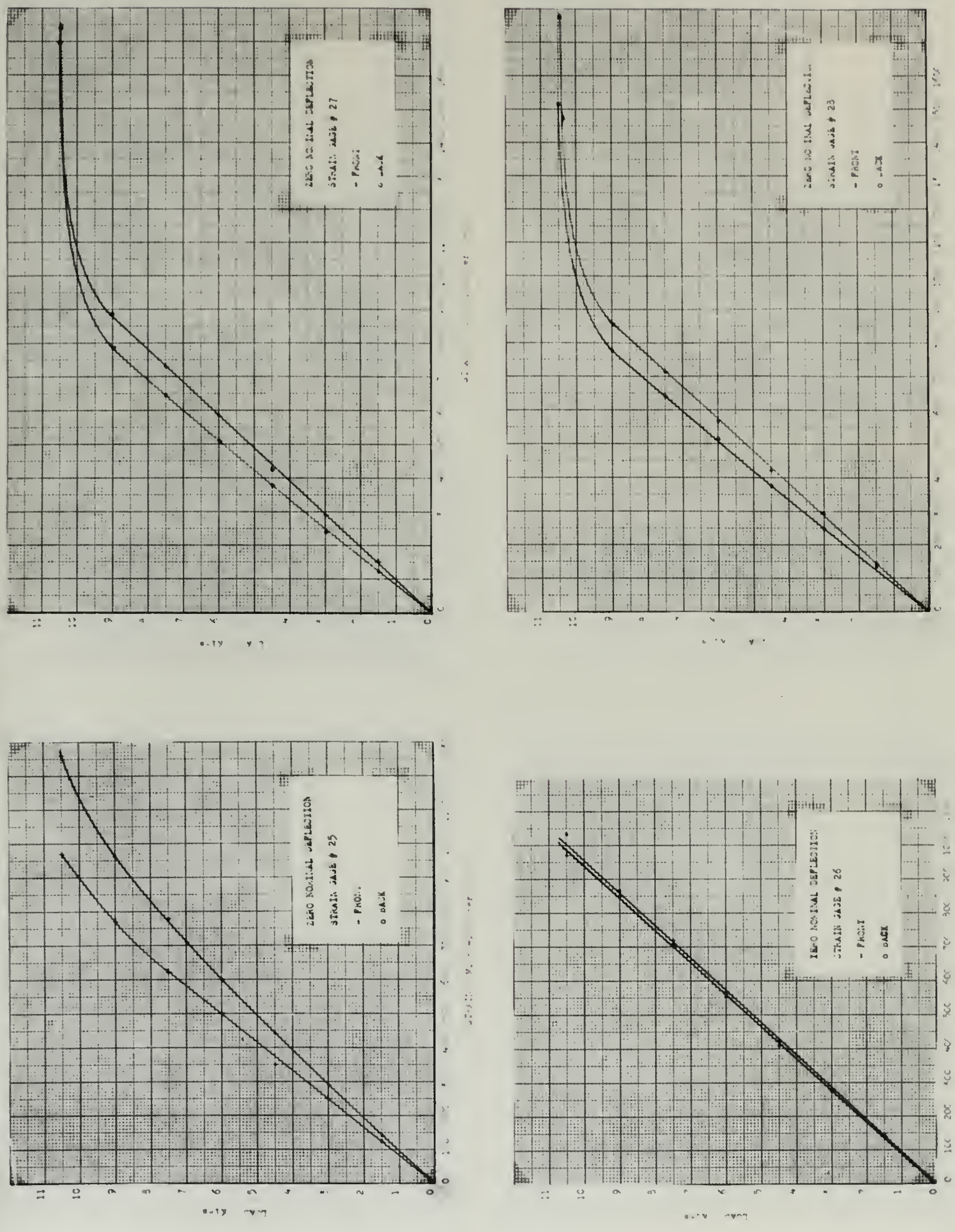
# FIGURE XIX


ZERO NOMINAL DEFLECTION
STRAIN GAGE # 19
- FRONT
o BACK
STRAIN Micro-inch per inch
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10 11
0 100 200 300 400 500 600 700 800 900 1000 1100 1200
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 20
- FRONT
o BACK
STRAIN Micro-inch per inch
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10 11
0 100 200 300 400 500 600 700 800 900 1000 1100
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 17
- FRONT
o BACK
STRAIN Micro-inch per inch
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10 11
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 18
- FRONT
o BACK
STRAIN Micro-inch per inch
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10 11
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800

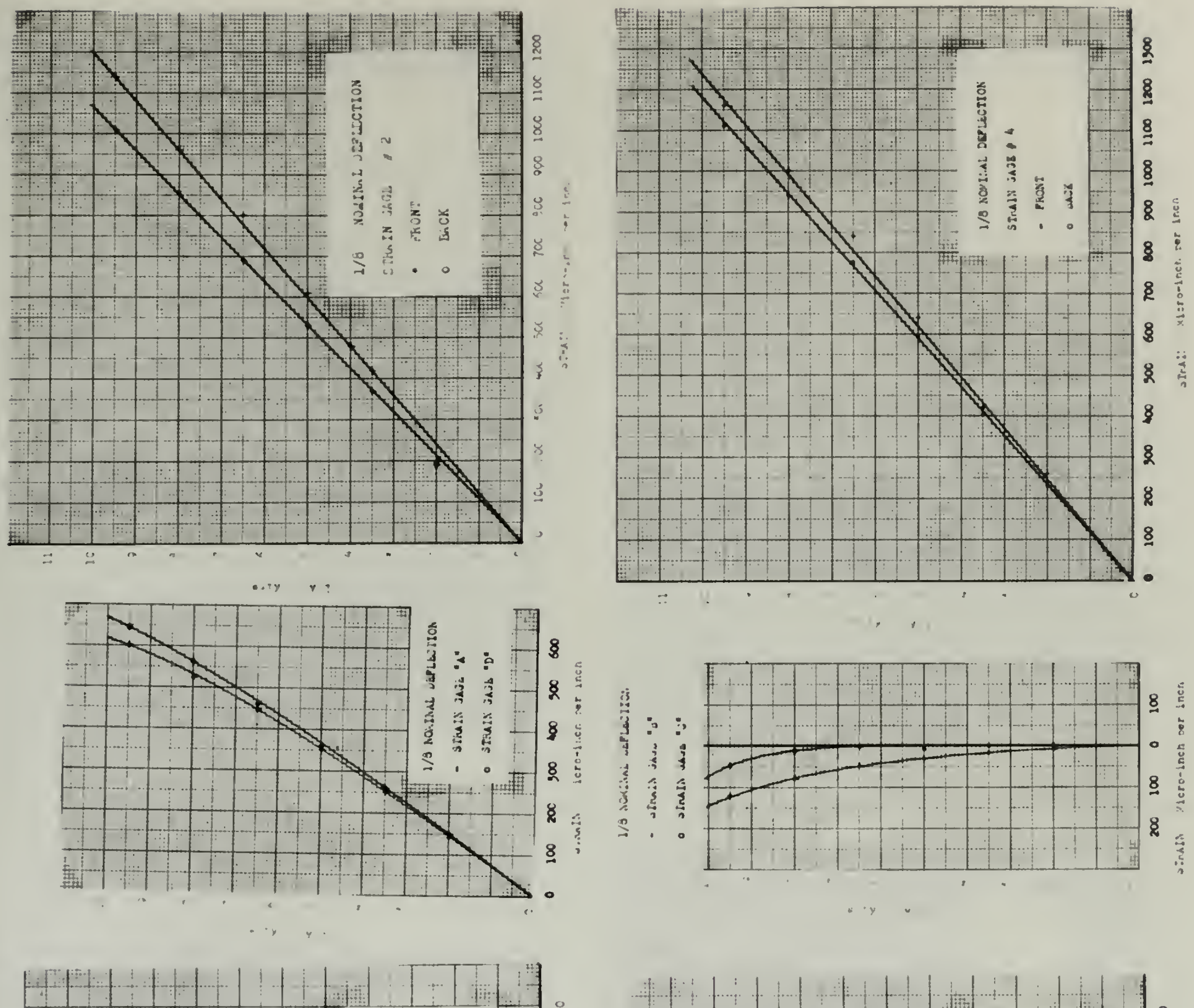
# FIGURE XX


ZERO NOMINAL DEFLECTION
STRAIN GAGE # 22
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 24
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 21
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 23
- FRONT
o BACK
0
1
2
3
4
5
6
7
8
9
10
11
0
100
200
300
400
500
600
STRAIN

# FIGURE XXI


ZERO NOMINAL DEFLECTION
STRAIN GAGE # 27
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 23
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 25
- FRONT
o BACK
ZERO NOMINAL DEFLECTION
STRAIN GAGE # 26
- FRONT
o BACK
0
1
2
3
4
5
6
7
8
9
10
11
0
100
200
300
400
500
600
700
800
900
1000

# FIGURE XXII


1/8 NOMINAL DEFLECTION
STRAIN GAGE # 2
• FRONT
o BACK
STRAIN Micro-inch per inch
0 100 200 300 400 500 600 700 800 900 1000 1100 1200
1/8 NOMINAL DEFLECTION
STRAIN GAGE # 4
• FRONT
o BACK
STRAIN Micro-inch per inch
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300
1/8 NOMINAL DEFLECTION
• STRAIN GAGE "A"
o STRAIN GAGE "D"
STRAIN Micro-inch per inch
0 100 200 300 400 500 600
1/8 NOMINAL DEFLECTION
STRAIN Micro-inch per inch
200 100 0 100
1/8 NOMINAL DEFLECTION
STRAIN GAGE # 1
• FRONT
o BACK
1/8 NOMINAL DEFLECTION
STRAIN GAGE # 3
• FRONT
o BACK
STRAIN Micro-inch per inch
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300

# FIGURE XXIII

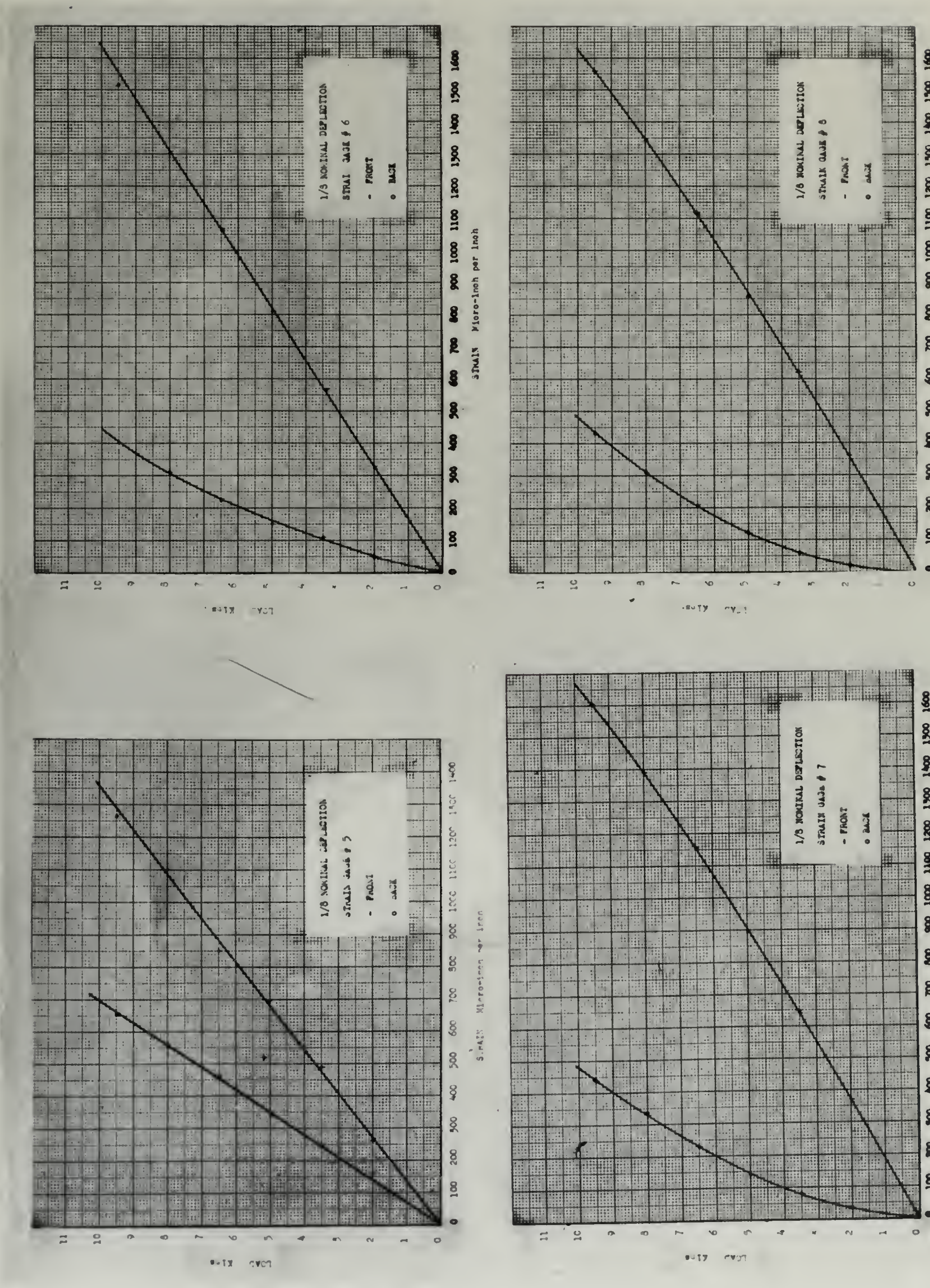


FIGURE XXIV

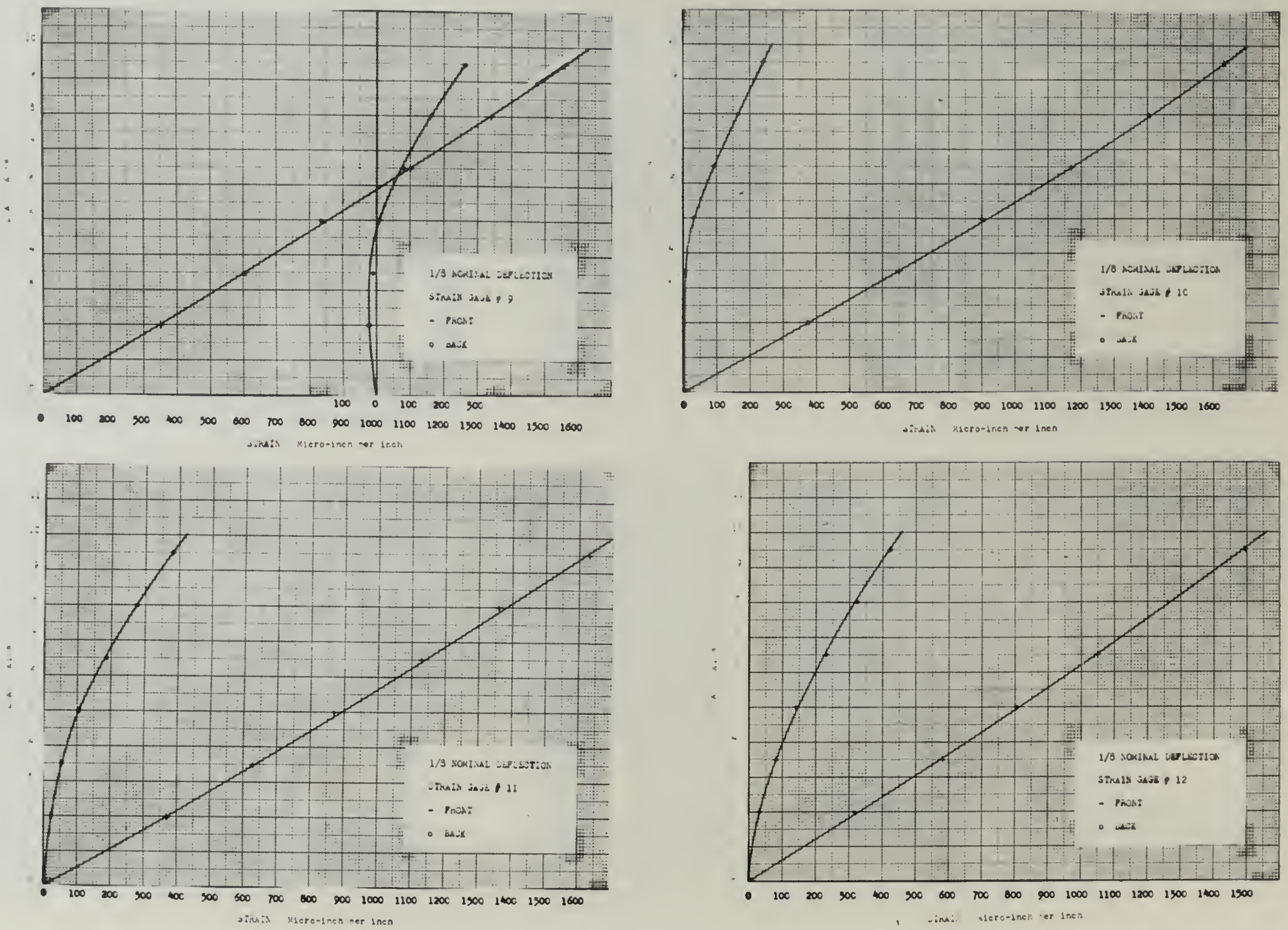
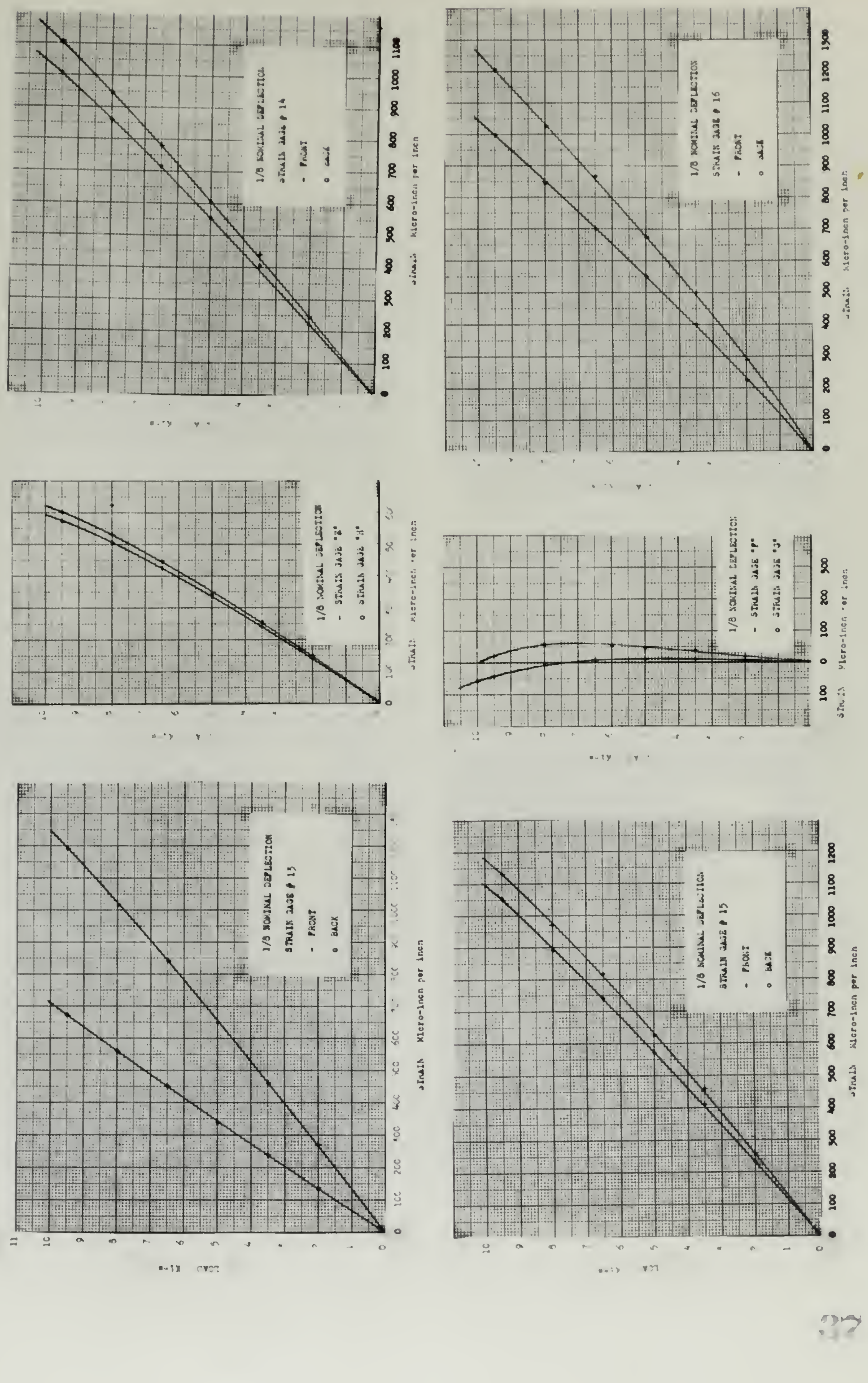
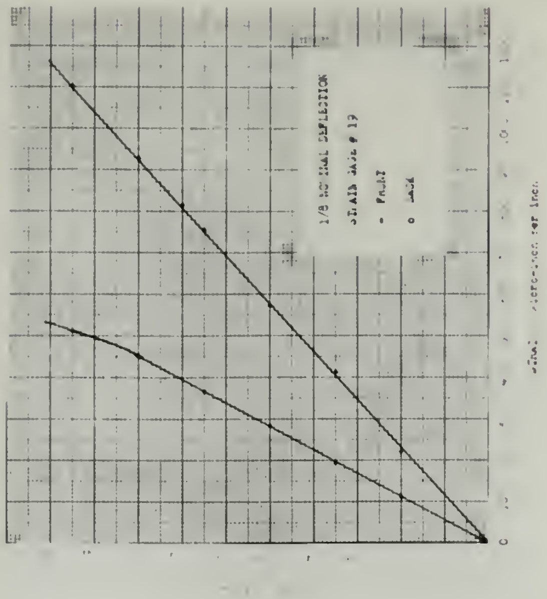
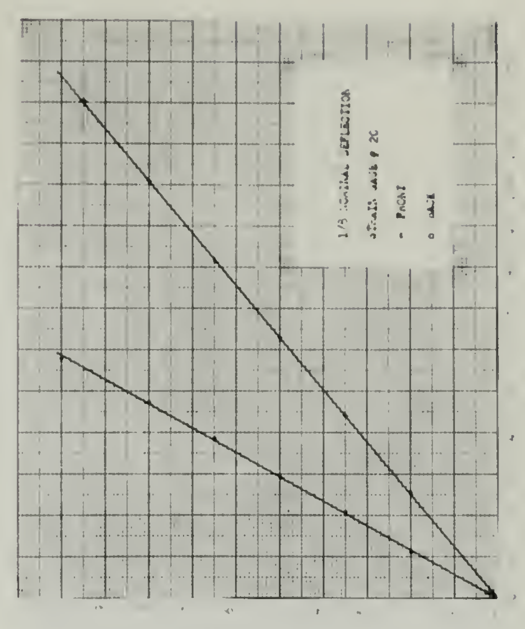

1/8 NOMINAL DEFLECTION
STRAIN GAGE # 9
- FRONT
o BACK
100 0 100 200 300
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
STRAIN Micro-inch per inch
1/8 NOMINAL DEFLECTION
STRAIN GAGE # 10
- FRONT
o BACK
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
STRAIN Micro-inch per inch
1/8 NOMINAL DEFLECTION
STRAIN GAGE # 11
- FRONT
o BACK
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600
STRAIN Micro-inch per inch
1/8 NOMINAL DEFLECTION
STRAIN GAGE # 12
- FRONT
o BACK
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
STRAIN Micro-inch per inch

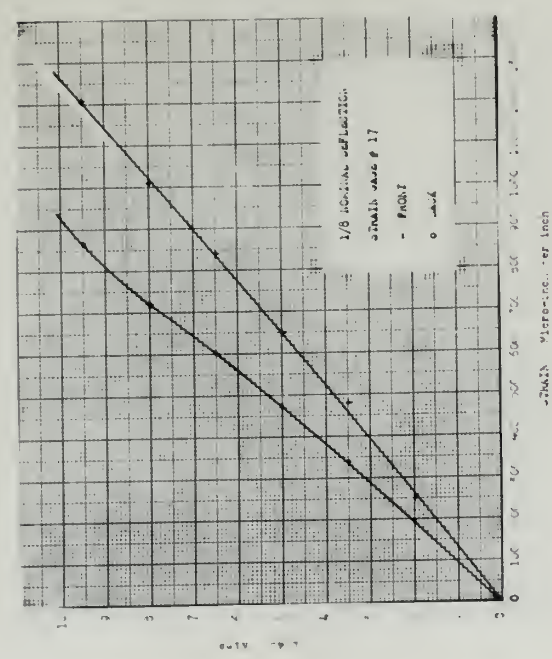
FIGURE XXV


1/8 NOMINAL DEFLECTION
STRAIN GAGE # 14
- FRONT
o BACK
STRAIN Micro-inch per inch
0 100 200 300 400 500 600 700 800 900 1000 1100
1/8 NOMINAL DEFLECTION
STRAIN GAGE # 16
- FRONT
o BACK
STRAIN Micro-inch per inch
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300
1/8 NOMINAL DEFLECTION
- STRAIN GAGE "E"
o STRAIN GAGE "H"
STRAIN Micro-inch per inch
1/8 NOMINAL DEFLECTION
- STRAIN GAGE "F"
o STRAIN GAGE "G"
STRAIN Micro-inch per inch
100 0 100 200 300
1/8 NOMINAL DEFLECTION
STRAIN GAGE # 13
- FRONT
o BACK
STRAIN Micro-inch per inch
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10 11
1/8 NOMINAL DEFLECTION
STRAIN GAGE # 15
- FRONT
o BACK
STRAIN Micro-inch per inch
0 100 200 300 400 500 600 700 800 900 1000 1100 1200
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10

# FIGURE XXVI


1/8 NOMINAL DEFLECTION
STRAIN GAGE # 19
- FRONT
o BACK
STRAIN Micro-inch per inch
0


1/8 NOMINAL DEFLECTION
STRAIN GAGE # 20
- FRONT
o BACK
STRAIN Micro-inch per inch


1/8 NOMINAL DEFLECTION
STRAIN GAGE # 17
- FRONT
o BACK
STRAIN Micro-inch per inch
0
100
200
300
400
500
600
700
800
900
1000
0
10

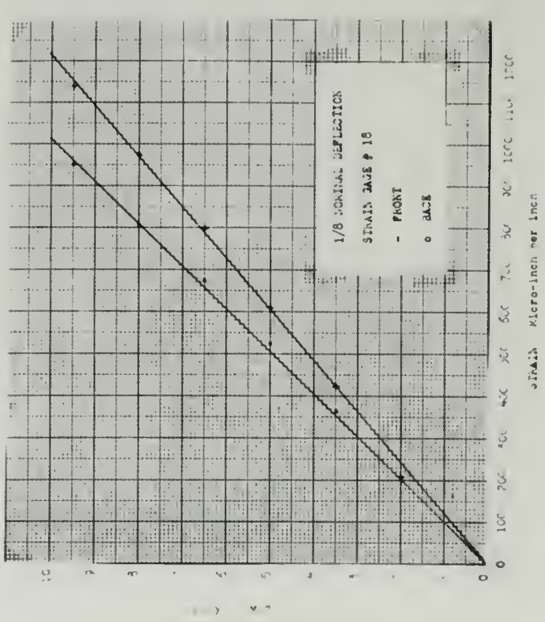
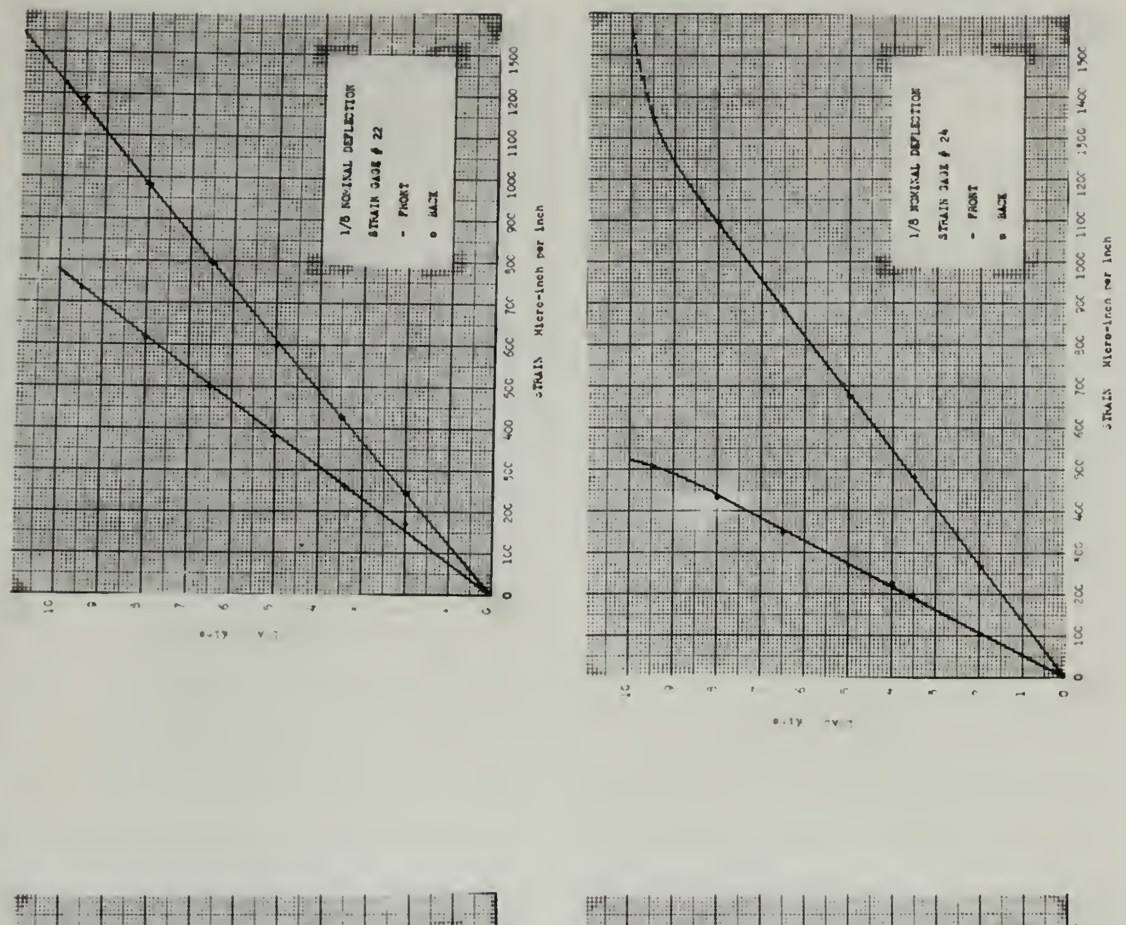
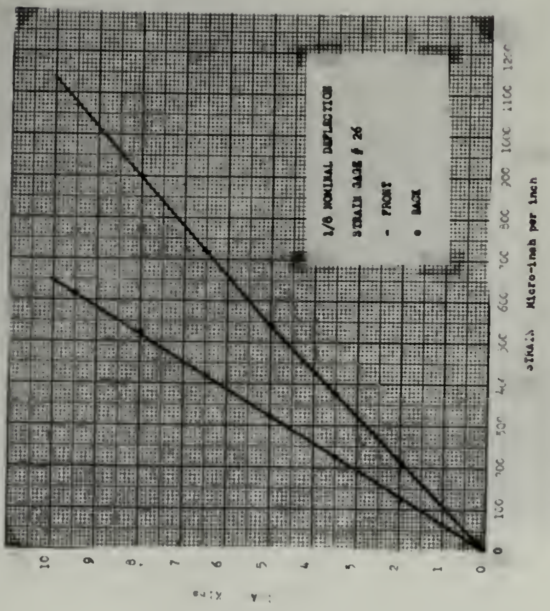
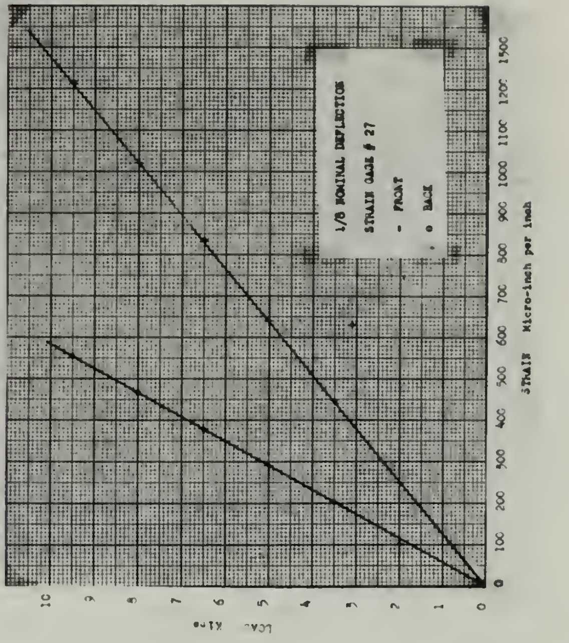

1/8 NOMINAL DEFLECTION
STRAIN GAGE # 18
- FRONT
o BACK
STRAIN Micro-inch per inch
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
0
10

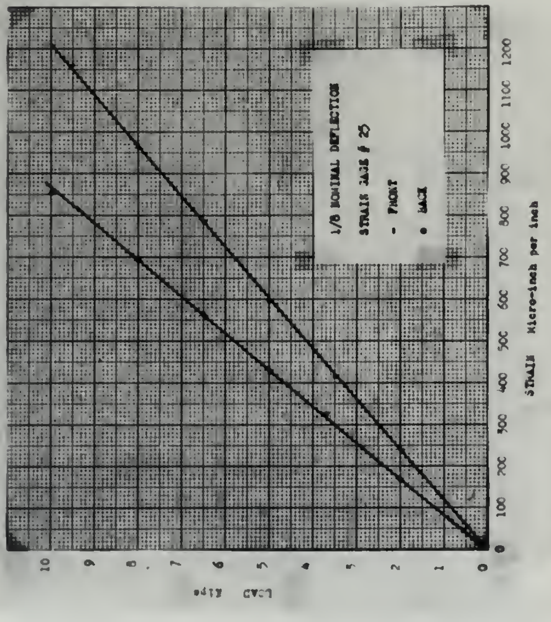
FIGURE XXVII

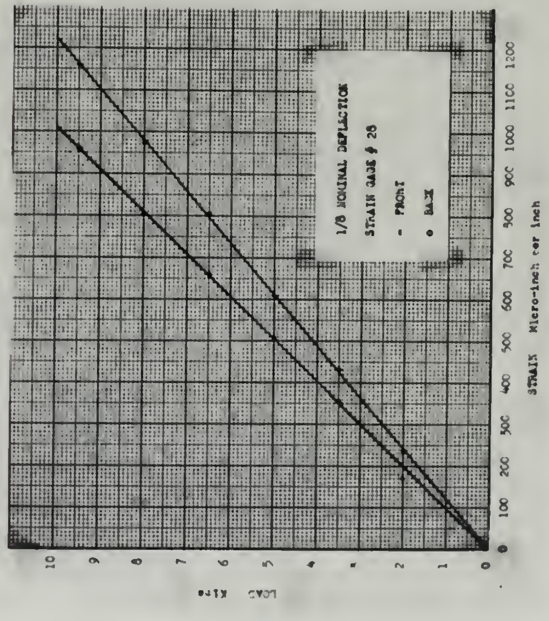


# FIGURE XXVIII









# FIGURE XXIX

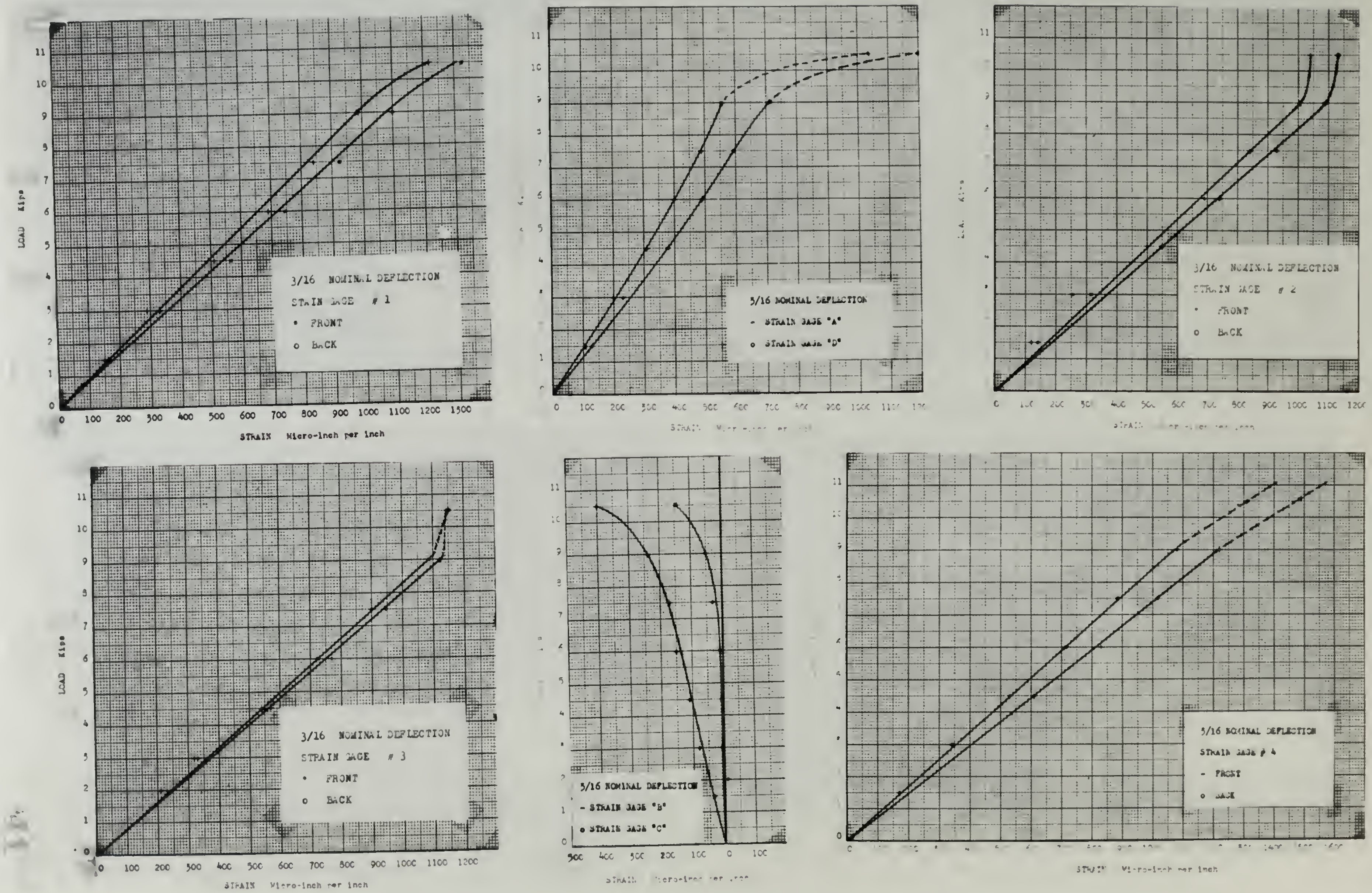

3/16 NOMINAL DEFLECTION
STRAIN GAGE # 1
• FRONT
o BACK
LOAD Kips
STRAIN Micro-inch per inch
3/16 NOMINAL DEFLECTION
- STRAIN GAGE "A"
o STRAIN GAGE "D"
3/16 NOMINAL DEFLECTION
STRAIN GAGE # 2
• FRONT
o BACK
3/16 NOMINAL DEFLECTION
STRAIN GAGE # 3
• FRONT
o BACK
LOAD Kips
STRAIN Micro-inch per inch
3/16 NOMINAL DEFLECTION
- STRAIN GAGE "B"
o STRAIN GAGE "C"
3/16 NOMINAL DEFLECTION
STRAIN GAGE # 4
- FRONT
o BACK
STRAIN Micro-inch per inch

FIGURE XXX

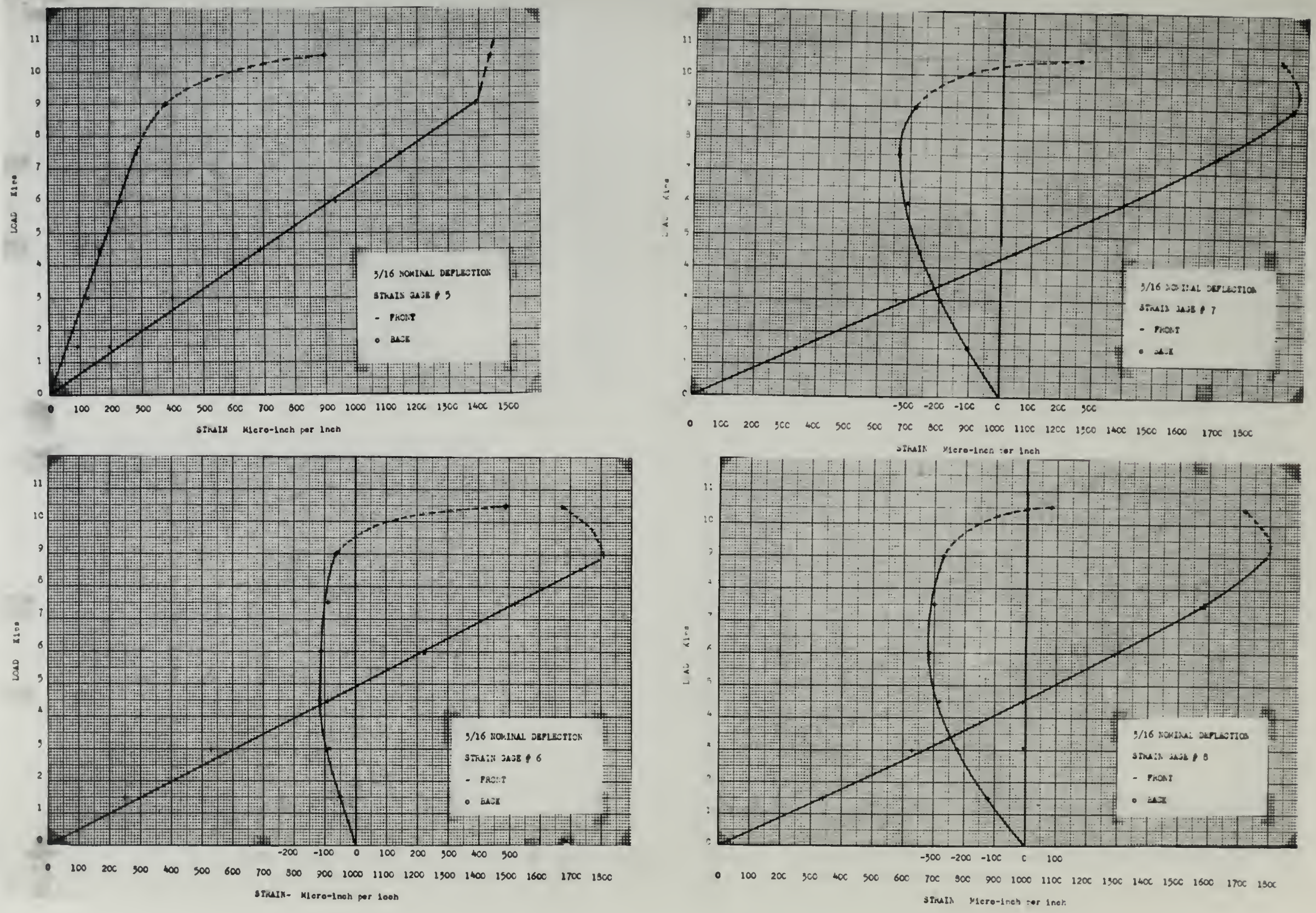

5/16 NOMINAL DEFLECTION
STRAIN GAGE # 5
- FRONT
o BACK
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10 11
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
STRAIN Micro-inch per inch
5/16 NOMINAL DEFLECTION
STRAIN GAGE # 7
- FRONT
o BACK
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10 11
-300 -200 -100 0 100 200 300
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800
STRAIN Micro-inch per inch
5/16 NOMINAL DEFLECTION
STRAIN GAGE # 6
- FRONT
o BACK
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10 11
-200 -100 0 100 200 300 400 500
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800
STRAIN- Micro-inch per inch
5/16 NOMINAL DEFLECTION
STRAIN GAGE # 8
- FRONT
o BACK
LOAD Kips
0 1 2 3 4 5 6 7 8 9 10 11
-300 -200 -100 0 100
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800
STRAIN Micro-inch per inch

FIGURE XXXI

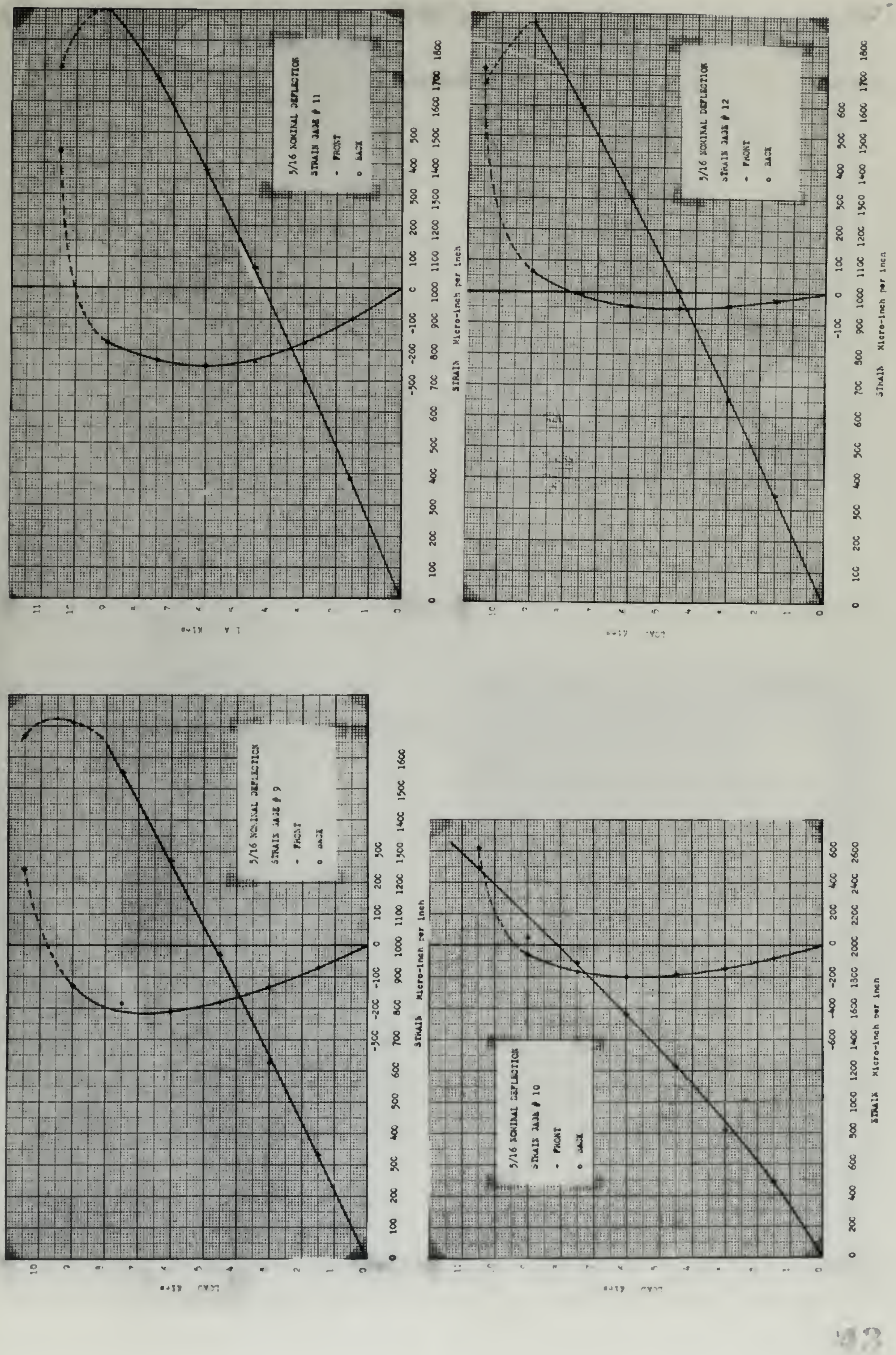
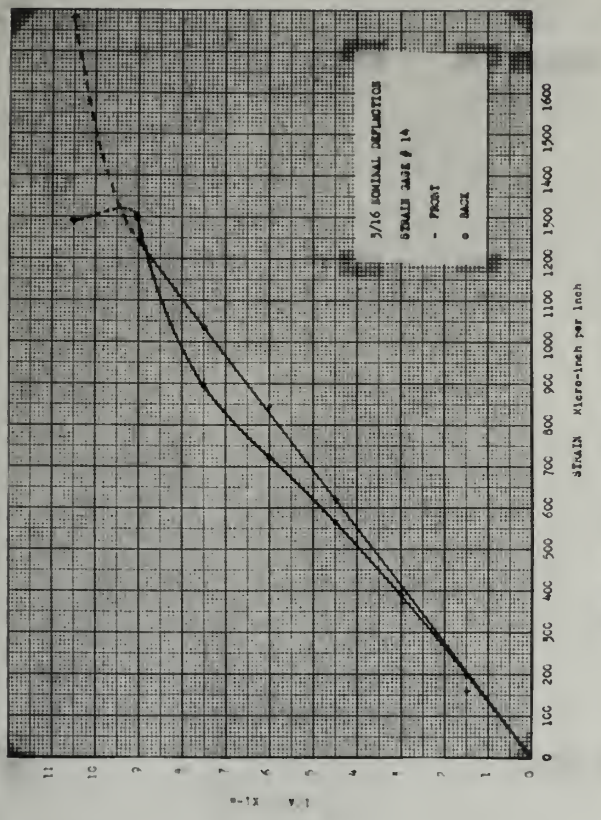
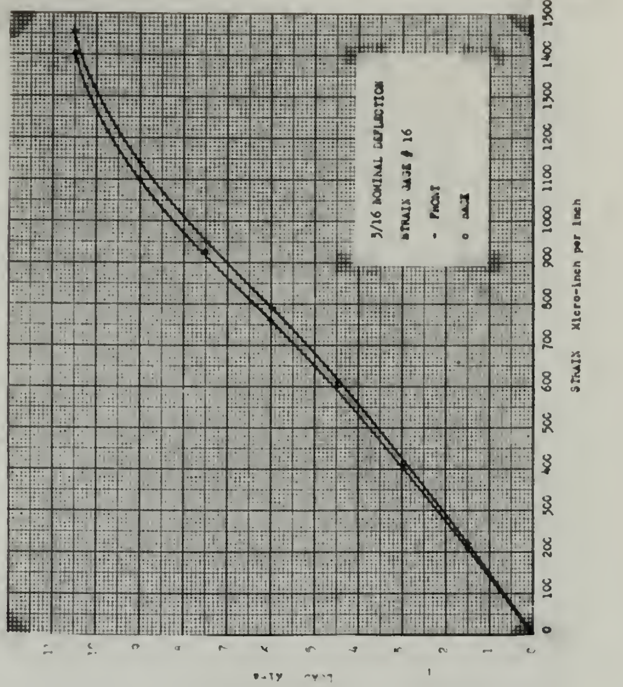
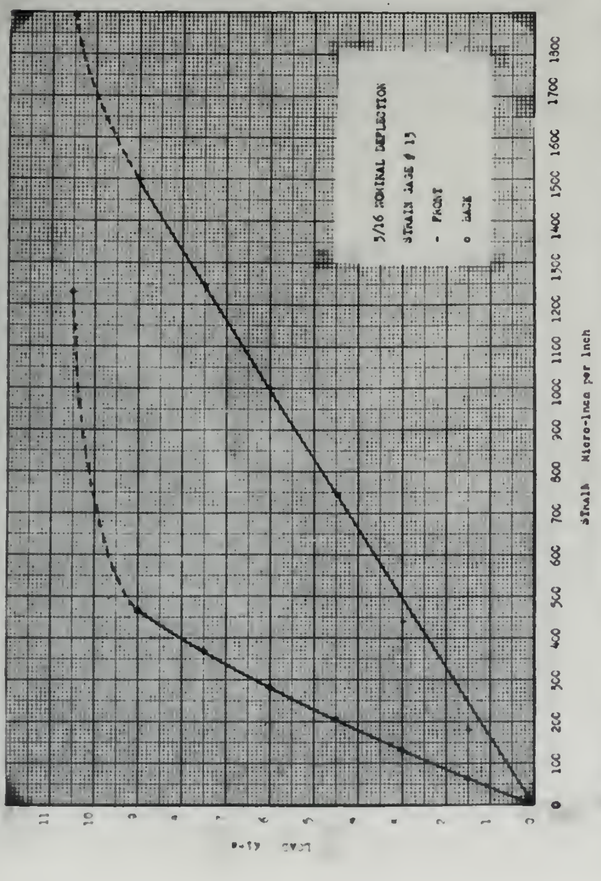
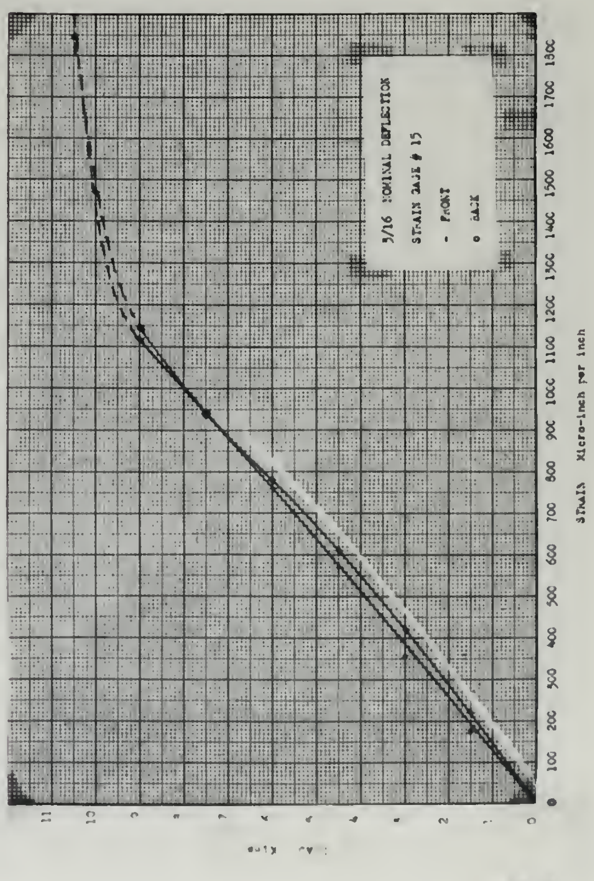

5/16 NOMINAL DEFLECTION
STRAIN GAGE # 11
- FRONT
o BACK
5/16 NOMINAL DEFLECTION
STRAIN GAGE # 12
- FRONT
o BACK
5/16 NOMINAL DEFLECTION
STRAIN GAGE # 9
- FRONT
o BACK
5/16 NOMINAL DEFLECTION
STRAIN GAGE # 10
- FRONT
o BACK
STRAIN Micro-inch per inch
LOAD Kips

FIGURE XXXII

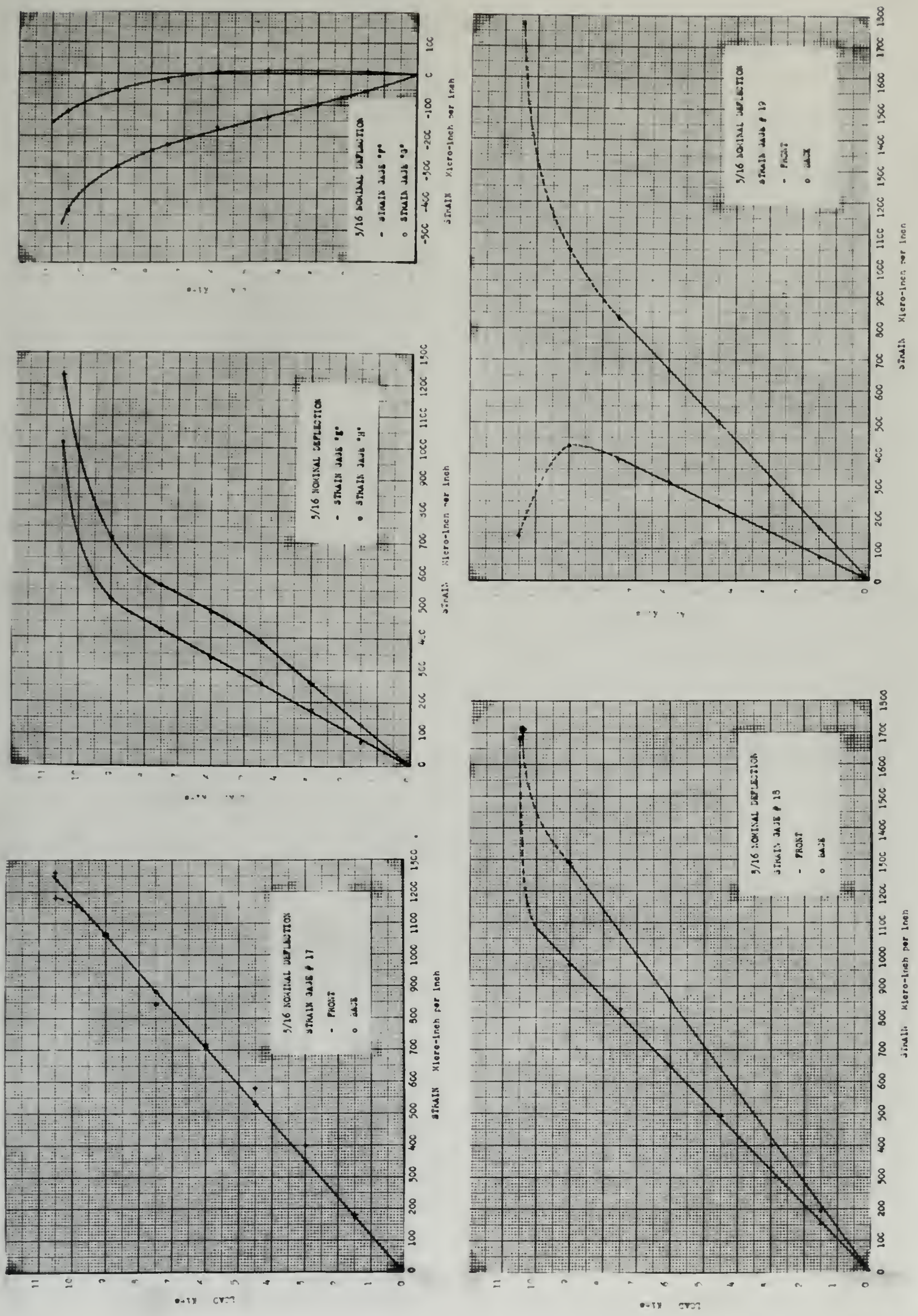




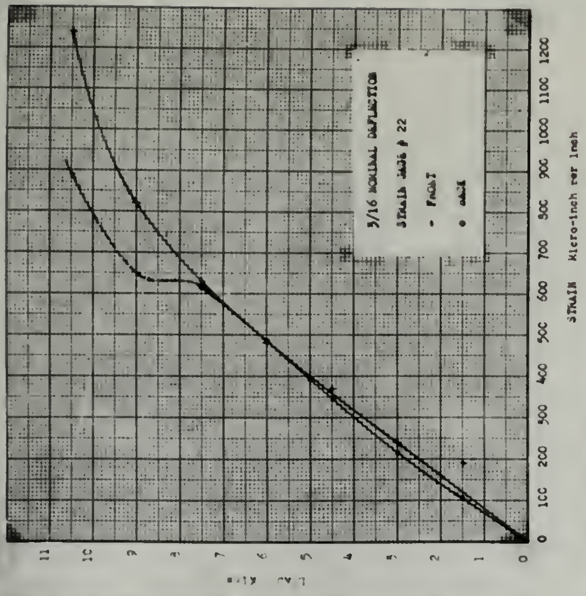


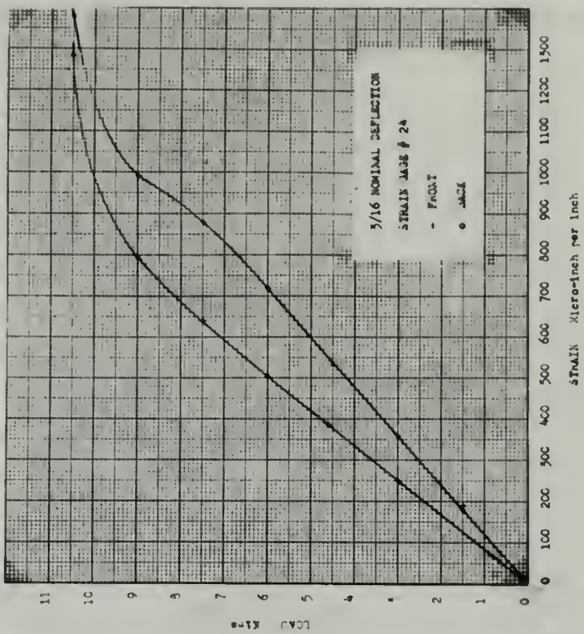


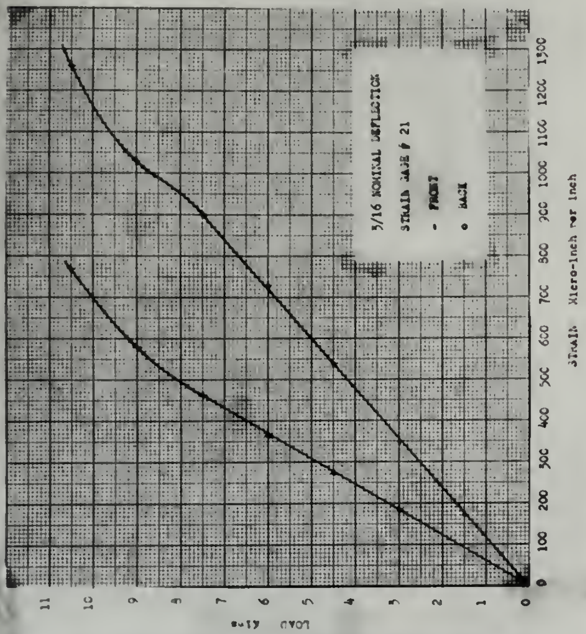
# FIGURE XXXIII

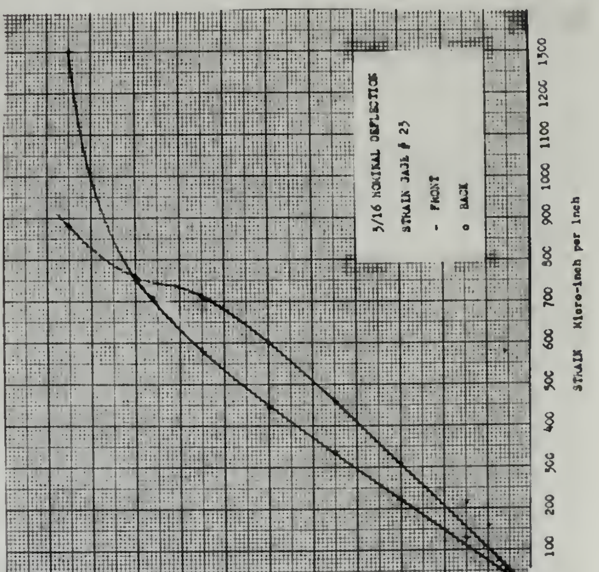


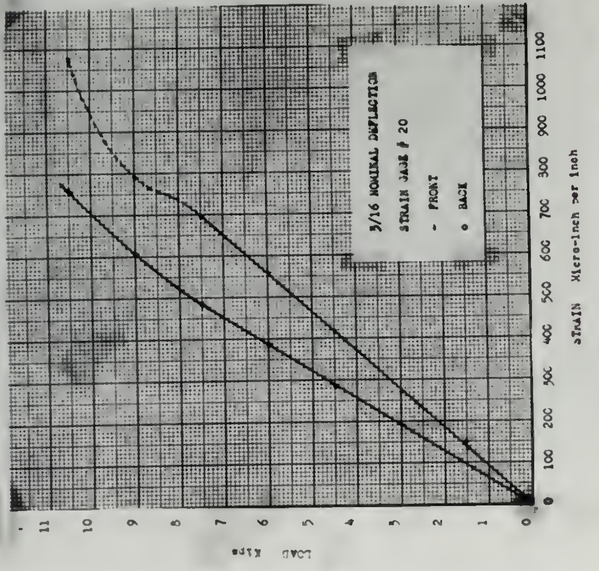
# FIGURE XXXIV



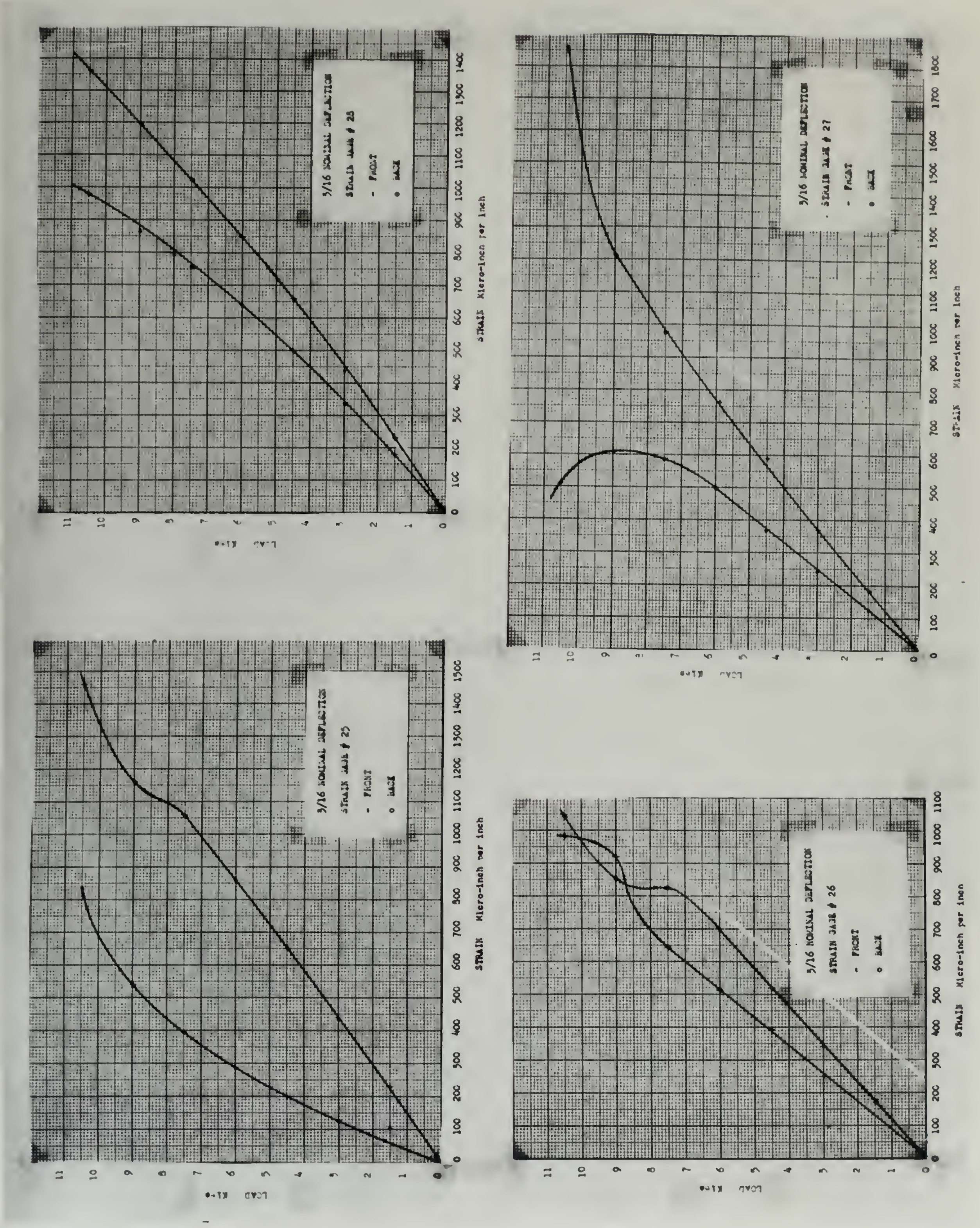




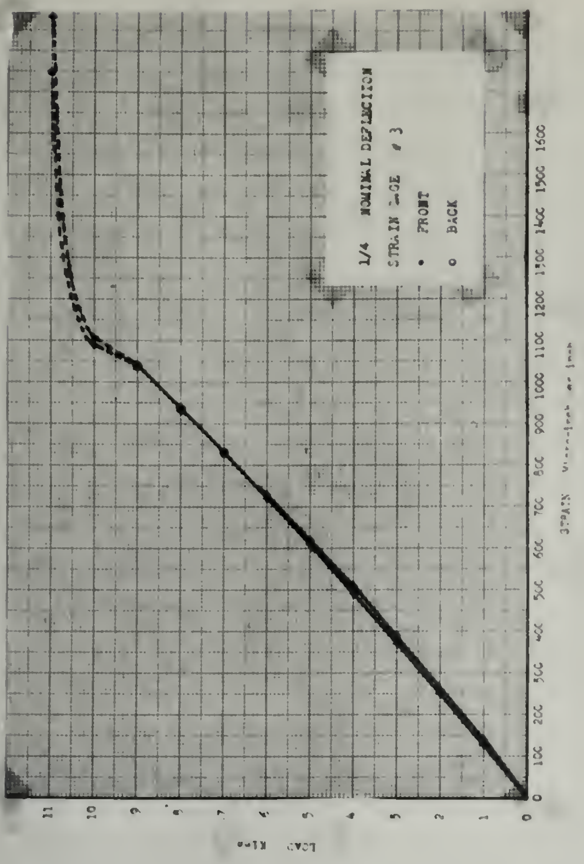


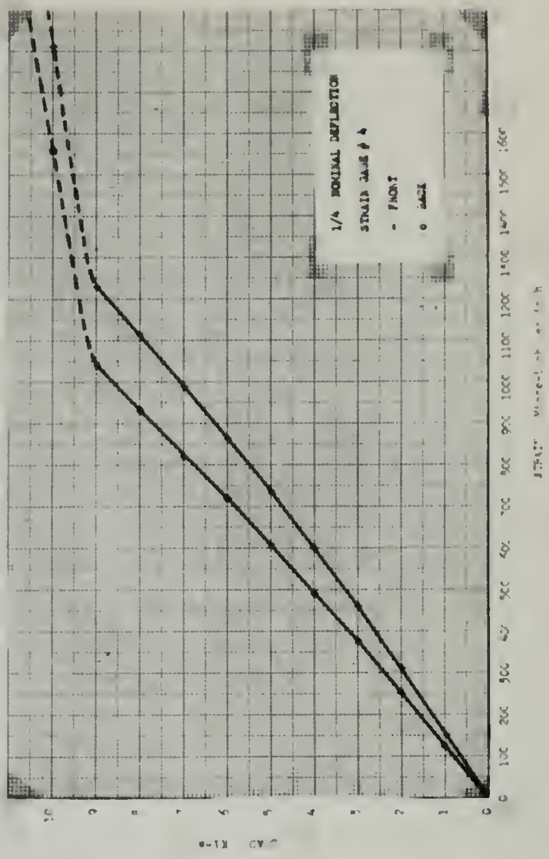


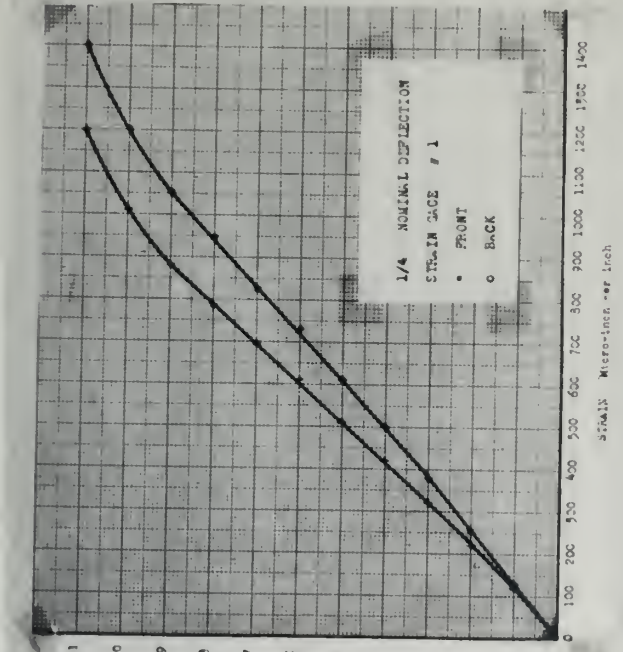
# FIGURE XXXV

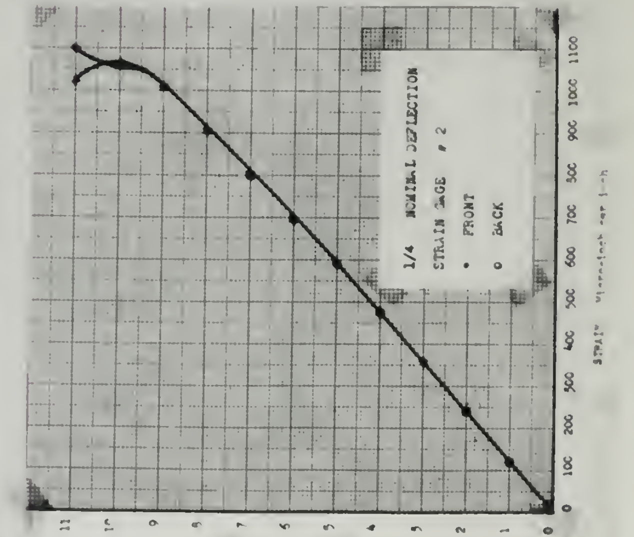

5/16 NOMINAL DEFLECTION
STRAIN GAGE # 28
- FRONT
o BACK
5/16 NOMINAL DEFLECTION
STRAIN GAGE # 27
- FRONT
o BACK
5/16 NOMINAL DEFLECTION
STRAIN GAGE # 25
- FRONT
o BACK
5/16 NOMINAL DEFLECTION
STRAIN GAGE # 26
- FRONT
o BACK
STRAIN Micro-inch per inch
LOAD Kips
0
1
2
3
4
5
6
7
8
9
10
11
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800

# FIGURE XXXVI

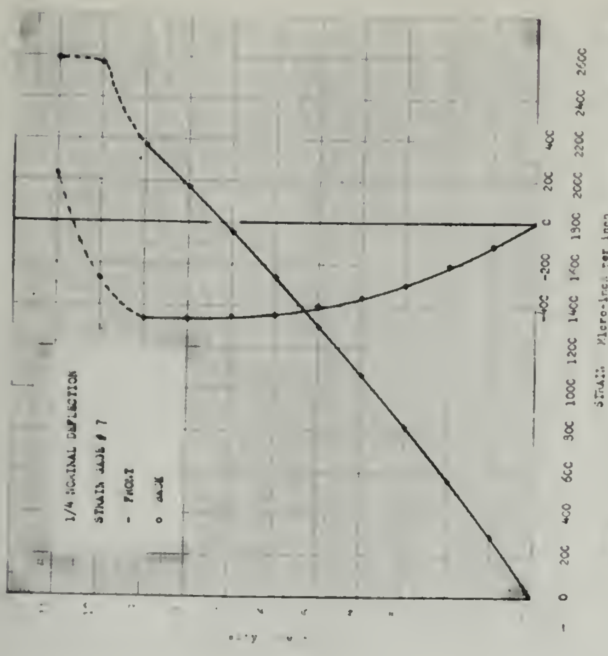


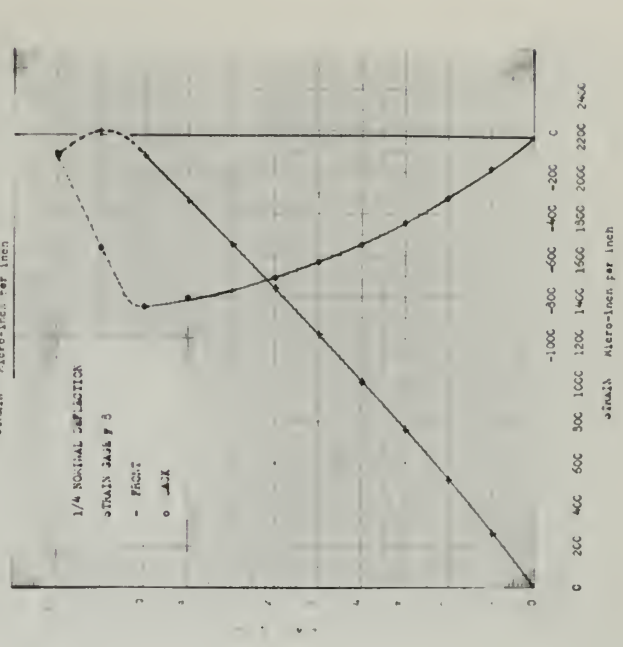


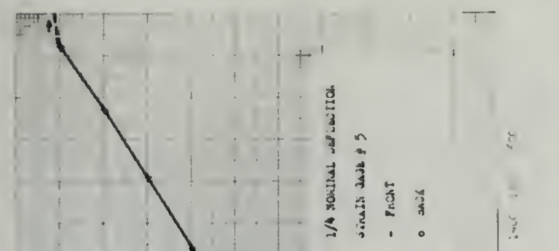


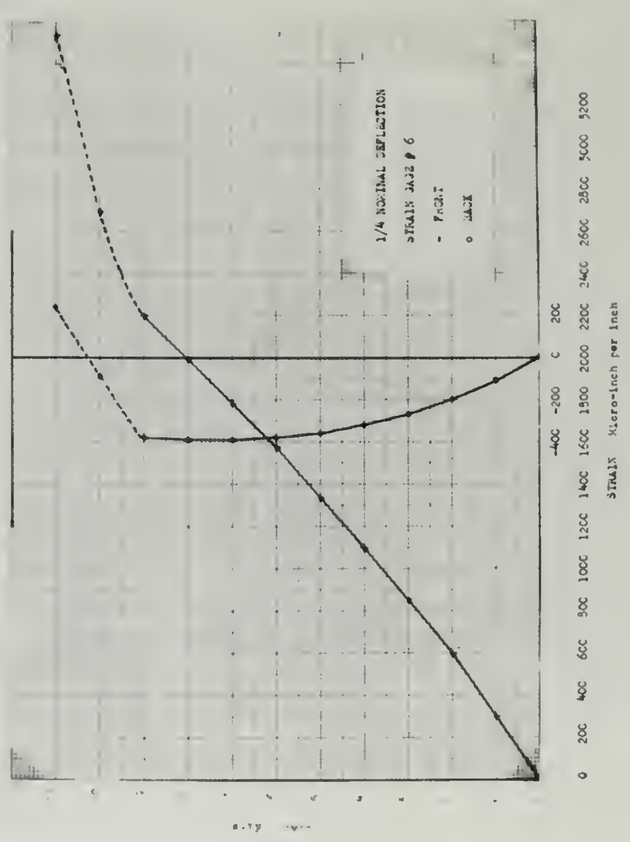


# FIGURE XXXVII

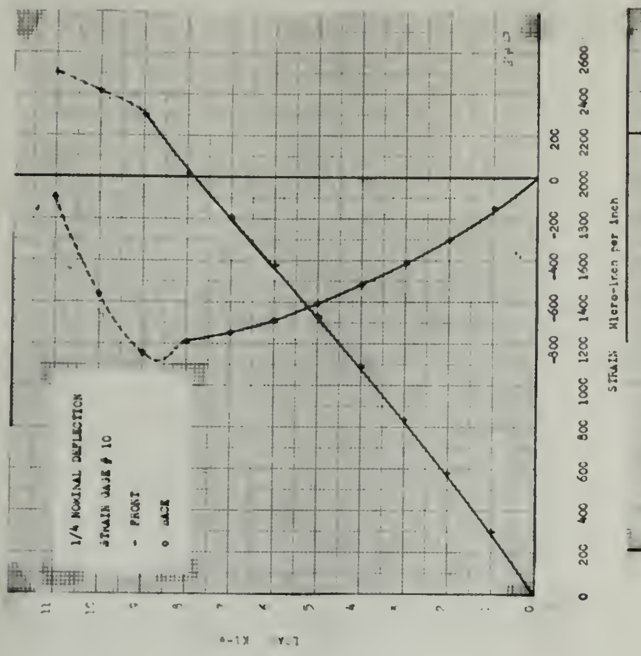


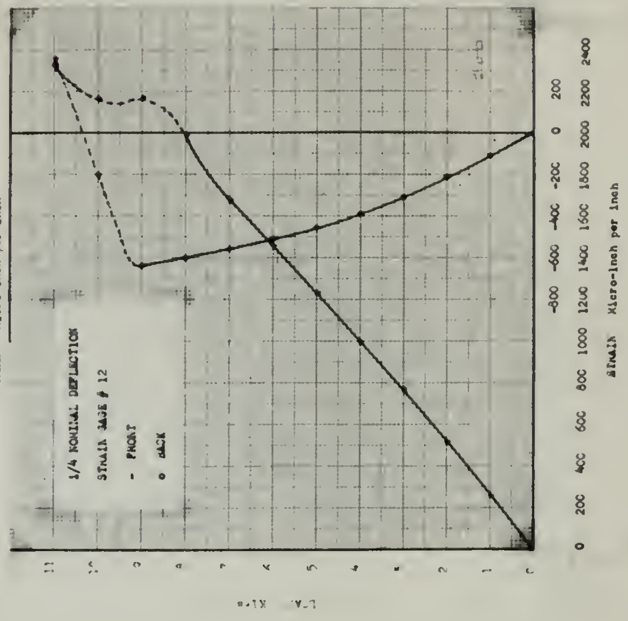


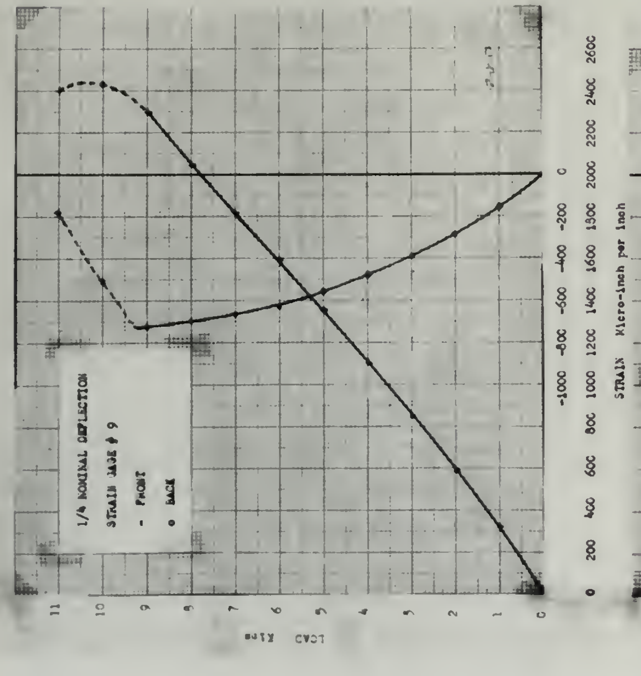


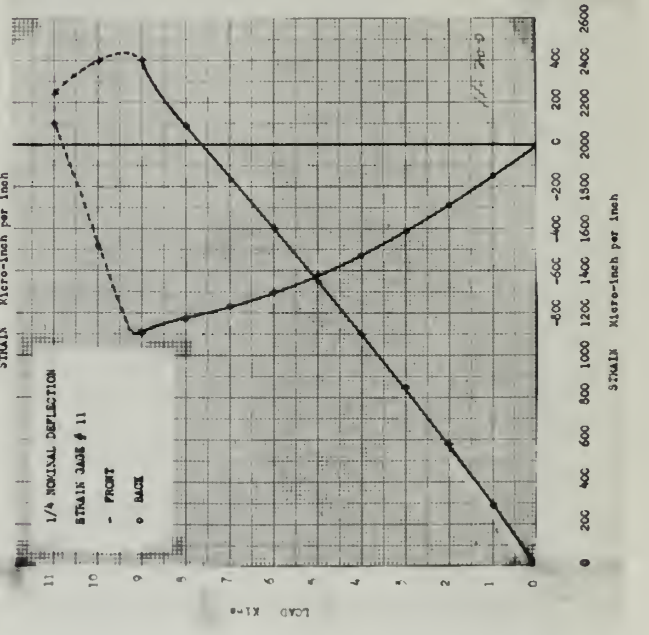


# FIGURE XXXVIII









# FIGURE XXXIX

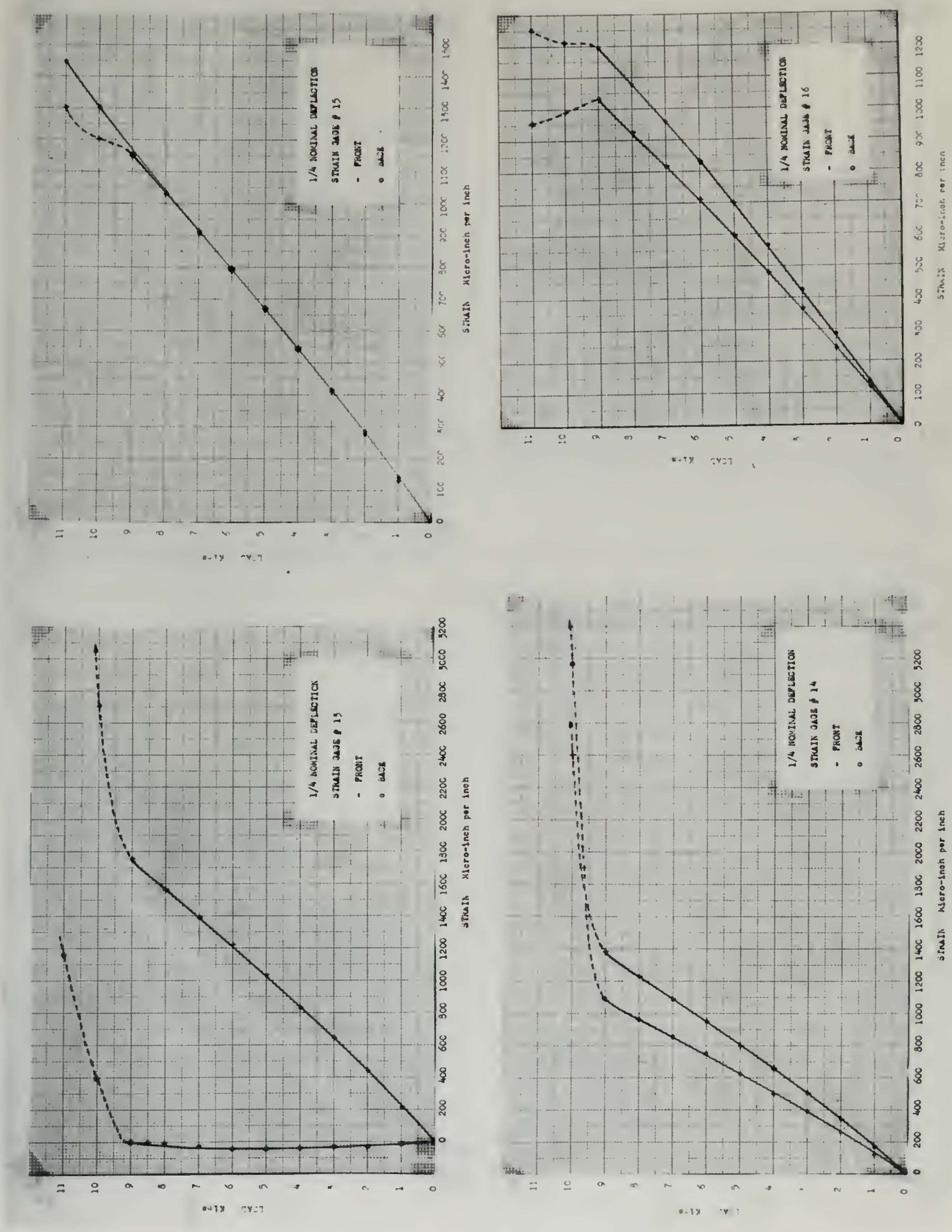


FIGURE XL

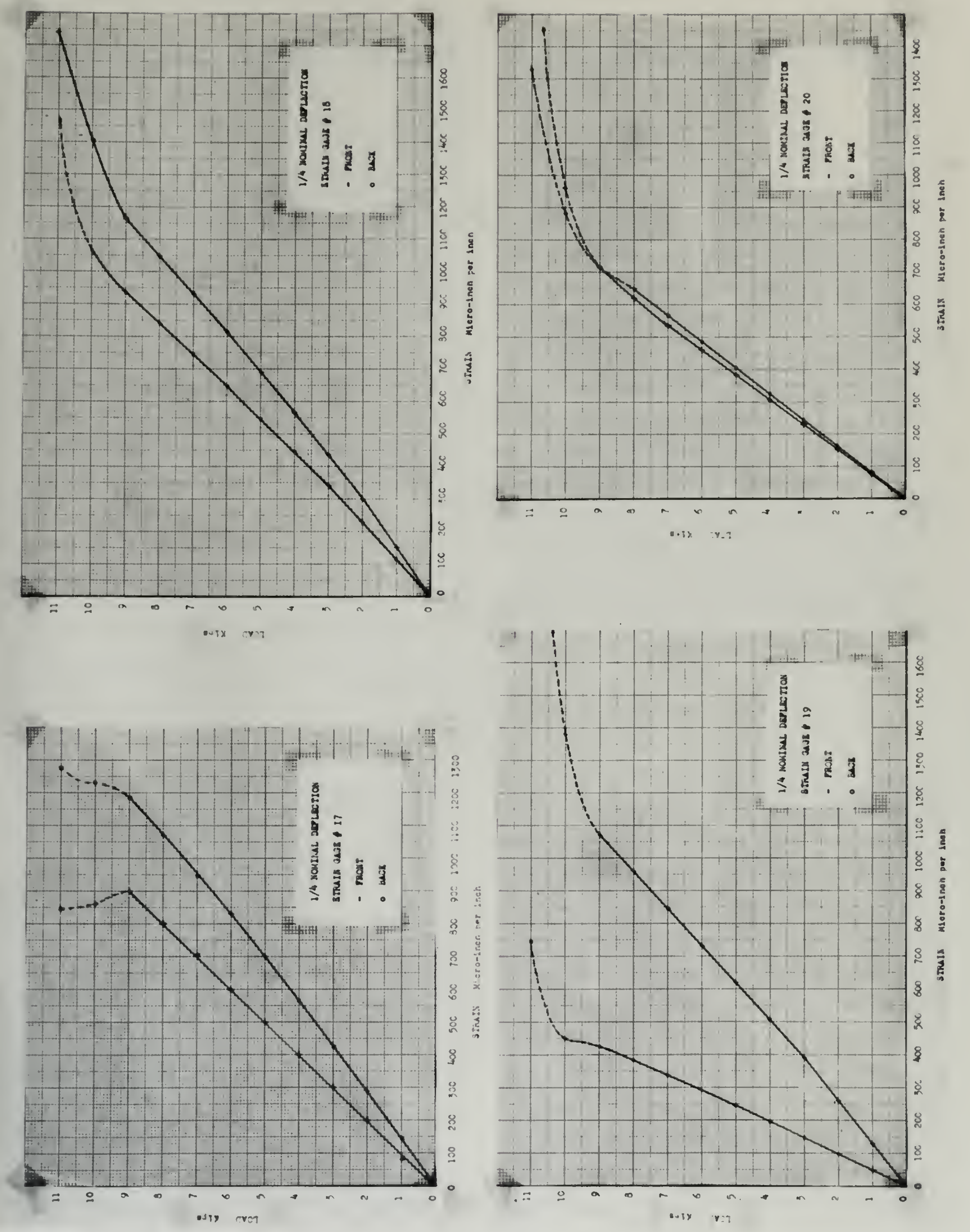
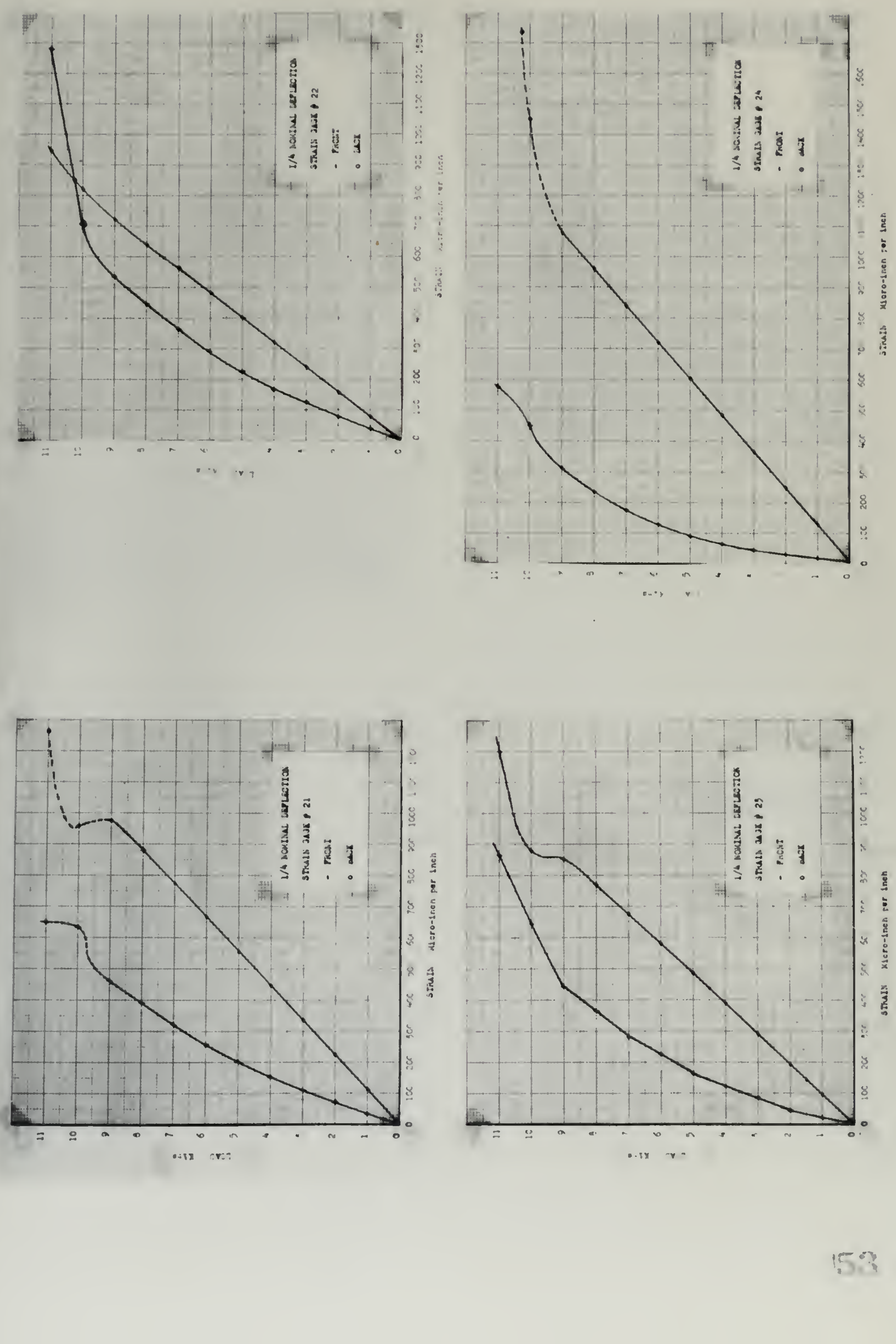
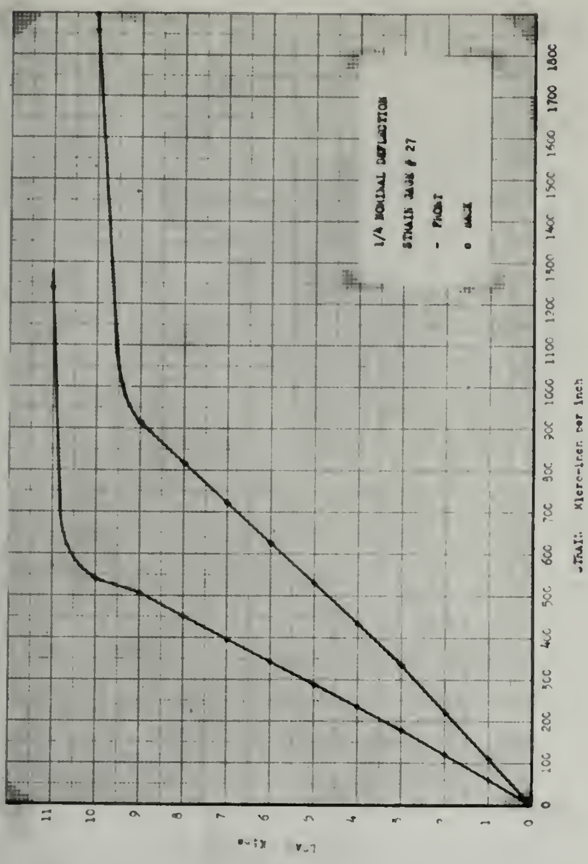
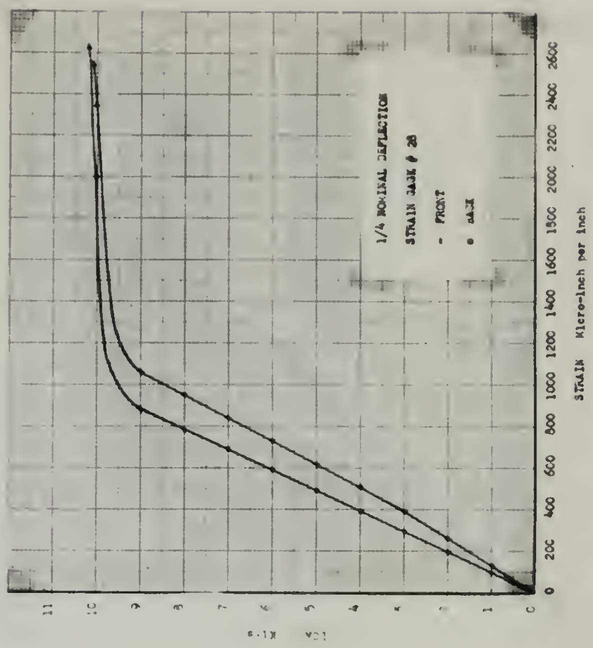

1/4 NOMINAL DEFLECTION
STRAIN GAGE # 18
- FRONT
o BACK
1/4 NOMINAL DEFLECTION
STRAIN GAGE # 20
- FRONT
o BACK
1/4 NOMINAL DEFLECTION
STRAIN GAGE # 17
- FRONT
o BACK
1/4 NOMINAL DEFLECTION
STRAIN GAGE # 19
- FRONT
o BACK
LOAD Kips
0
1
2
3
4
5
6
7
8
9
10
11
STRAIN Micro-inch per inch
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600

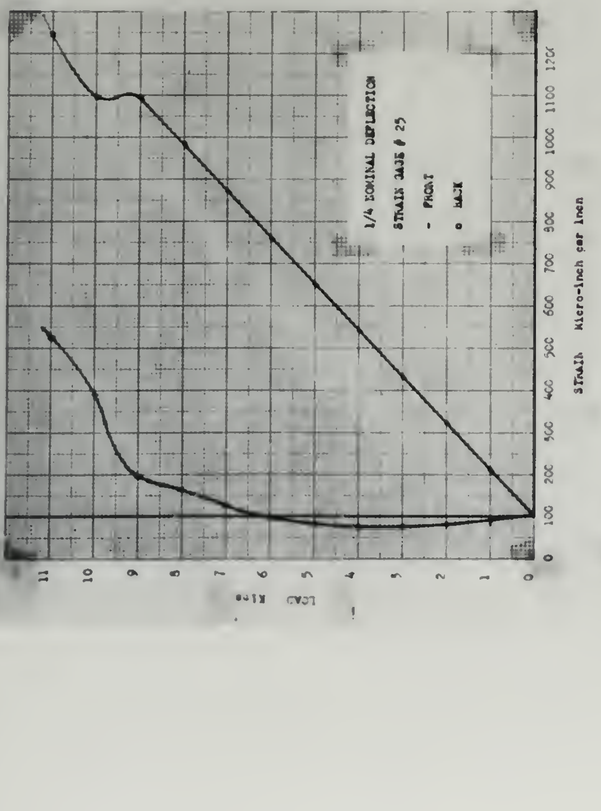
FIGURE XLI


1/4 NOMINAL DEFLECTION
STRAIN GAGE # 22
- FRONT
o BACK
1/4 NOMINAL DEFLECTION
STRAIN GAGE # 24
- FRONT
o BACK
1/4 NOMINAL DEFLECTION
STRAIN GAGE # 21
- FRONT
o BACK
1/4 NOMINAL DEFLECTION
STRAIN GAGE # 23
- FRONT
o BACK
STRAIN Micro-inch per inch
LOAD KIPS
0
1
2
3
4
5
6
7
8
9
10
11
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500

# FIGURE XLII


1/4 NOMINAL DEFLECTION
STRAIN GAGE # 27
- FRONT
o BACK
LOAD Kips
0
1
2
3
4
5
6
7
8
9
10
11
STRAIN Micro-inch per inch
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800


1/4 NOMINAL DEFLECTION
STRAIN GAGE # 28
- FRONT
o BACK
LOAD Kips
0
1
2
3
4
5
6
7
8
9
10
11
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600


1/4 NOMINAL DEFLECTION
STRAIN GAGE # 25
- FRONT
o BACK
LOAD Kips
0
1
2
3
4
5
6
7
8
9
10
11
STRAIN Micro-inch per inch
0
100
200
300
400
500
600
700
800
900
1000
1100
1200

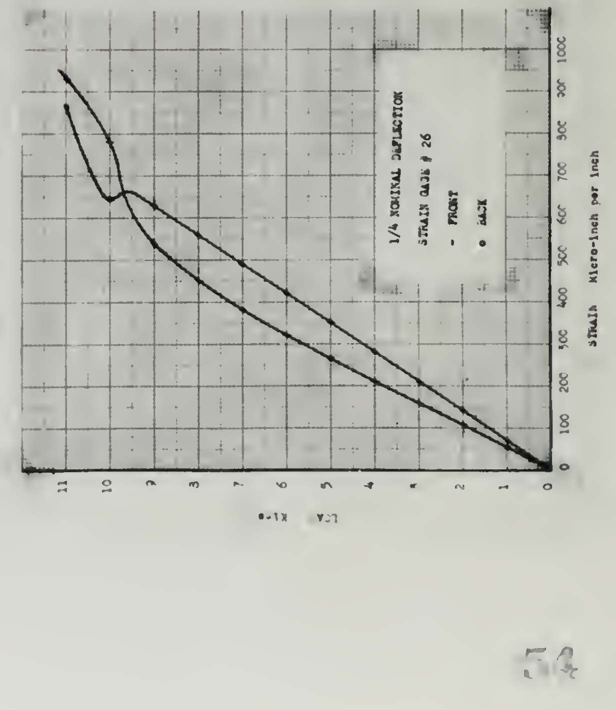
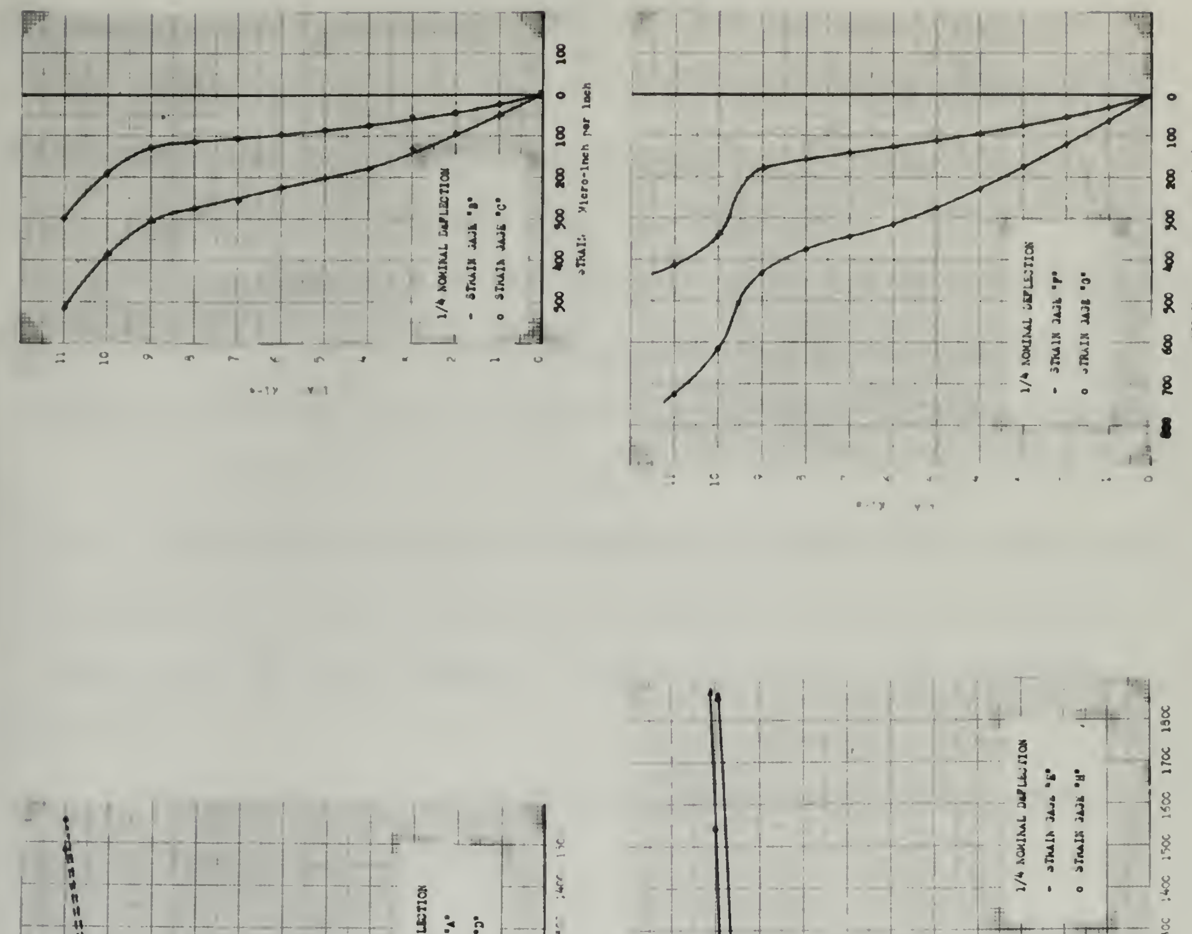

1/4 NOMINAL DEFLECTION
STRAIN GAGE # 26
- FRONT
o BACK
LOAD Kips
0
1
2
3
4
5
6
7
8
9
10
11
STRAIN Micro-inch per inch
0
100
200
300
400
500
600
700
800
900
1000

FIGURE XLIII



The maximum value of the strain in the front face at each level of load was obtained by taking the arithmetical mean of the strain values indicated by gages 7 front and 11 front.

The minimum value of the strain on the back face at each level of load was computed by taking the arithmetical mean average of the strain values of gages 8 back, 9 back, and 10 back.

The maximum value of the strain at the mid-depth of the plate at each level of load was calculated by taking the arithmetical mean average of the strain values of gages 4 front, 4 back, 14 front, and 14 back.

The ratios of maximum and minimum to average strain values were plotted against the ratios of average deflection (obtained as indicated in section 2.4) to plate thickness. These curves are shown in Figure LVII.

Table VII in the Appendix C contains the calculation of the values and ratios mentioned above.

## 2.11 Measured and Calculated Applied Load

The product of the average strain, the cross-sectional area of the plate, and the modulus of elasticity equals the magnitude of the load supported by the plate.

From the curves of the strain distribution in the stiffeners, shown in Figure LVI, the arithmetical mean average strain in the two stiffeners of each plate was obtained. Multiplying this value by the product of the cross-sectional area of the stiffeners and the modulus of elasticity gives the magnitude of the load supported by the stiffeners.

The sum of the load on the plate and the load on the stiffeners should be equal to the applied load. This comparison was made for a load of 60,000 pounds, assuming a modulus of elasticity of the material of 29,000,000 pounds per square inch, and the difference between the applied load and the calculated load was

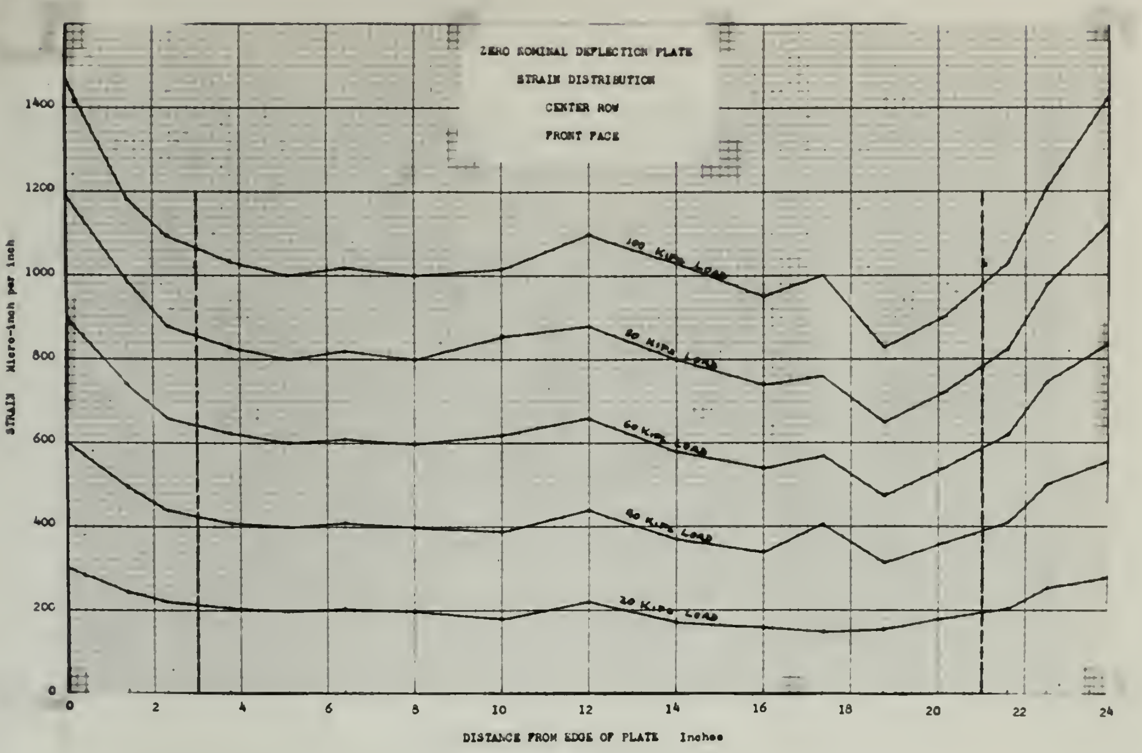
- 800 pounds or -1.33% for the plate of zero nominal deflection
5400 pounds or 9 % for the plate of 1/8" nominal deflection
4000 pounds or 6.7 % for the plate of 3/16" nominal deflection
-1100 pounds or -1.8 % for the plate of 1/4" nominal deflection.

The differences were considered small and within the accuracy of the measurements. The calculation is shown in Appendix D.

# III RESULTS

The results of this investigation are shown in Figures XLIV through LVII.

FIGURE XLIV


ZERO NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
CENTER ROW
FRONT FACE
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
1400
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE Inches

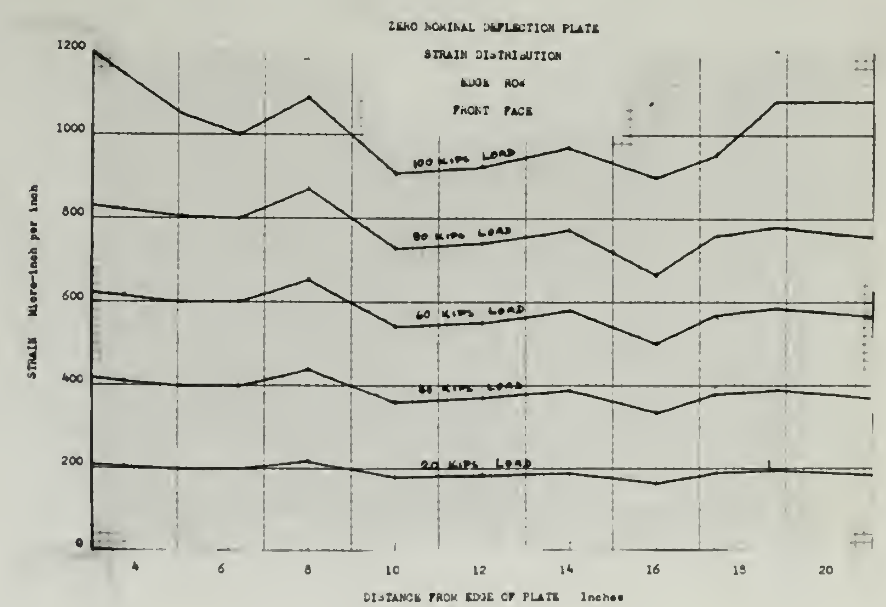
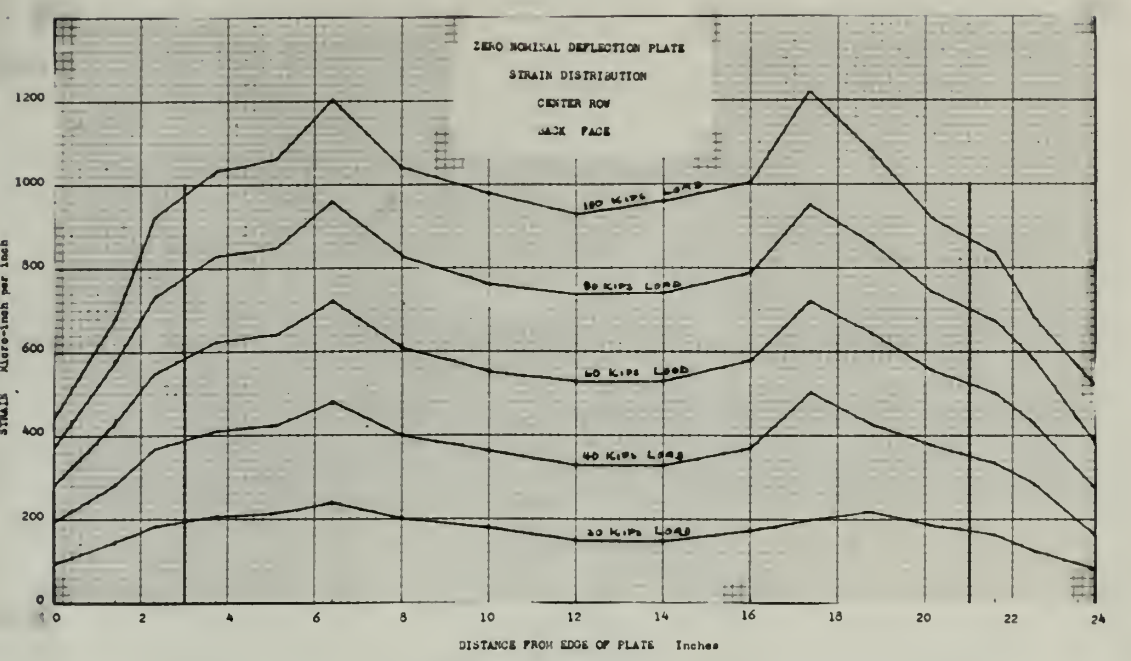
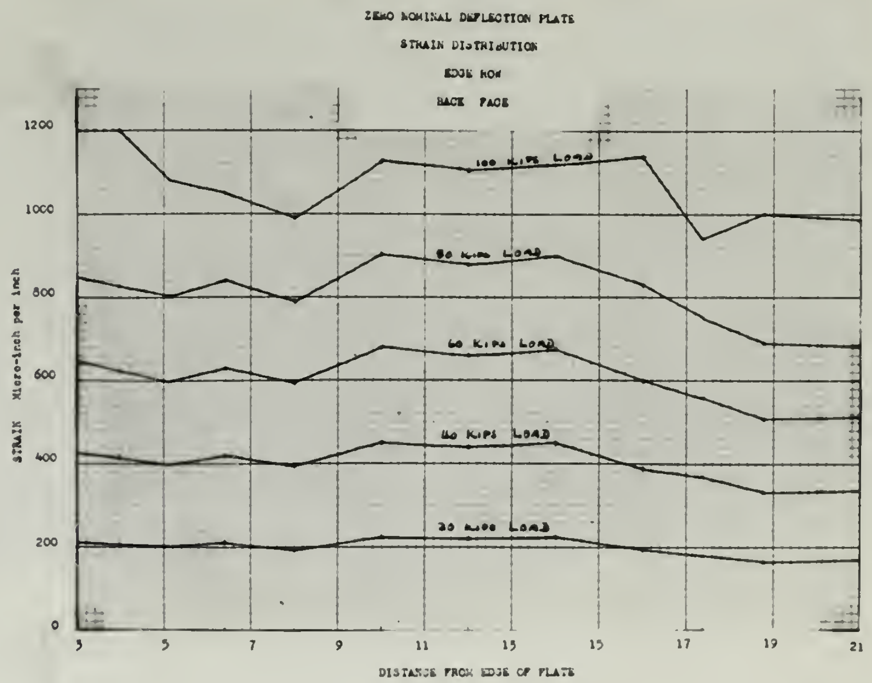
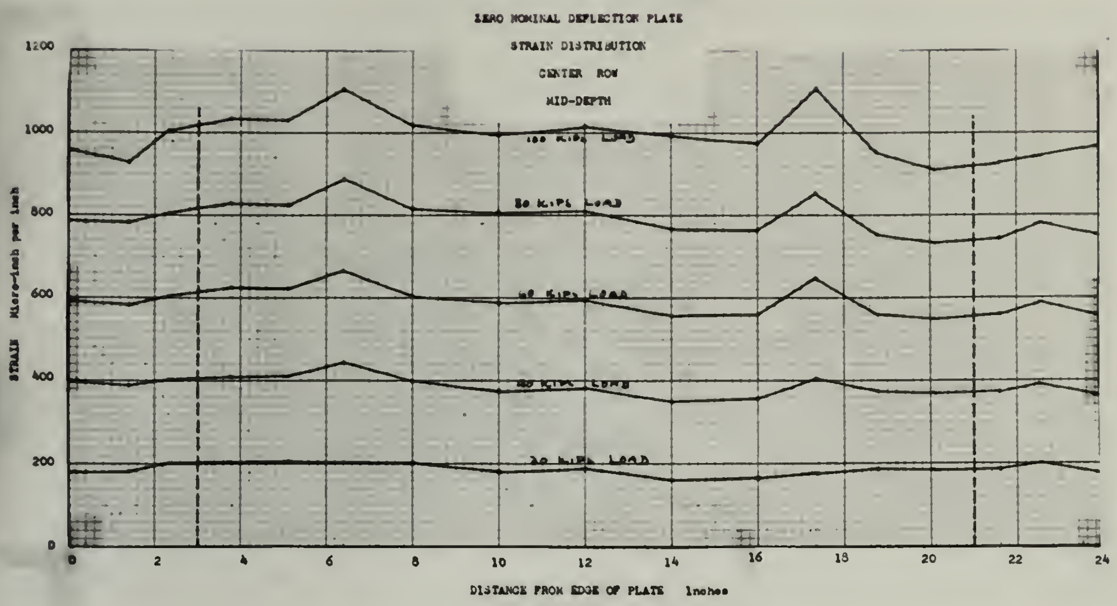

ZERO NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
FRONT FACE
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
4
6
8
10
12
14
16
18
20
DISTANCE FROM EDGE OF PLATE Inches

FIGURE XLV


ZERO NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
CENTER ROW
BACK FACE
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE Inches


ZERO NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
BACK FACE
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
3
5
7
9
11
13
15
17
19
21
DISTANCE FROM EDGE OF PLATE

# FIGURE XLVI


ZERO NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
CENTER ROW
MID-DEPTH
100 Kips Load
80 Kips Load
60 Kips Load
40 Kips Load
20 Kips Load
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE inches

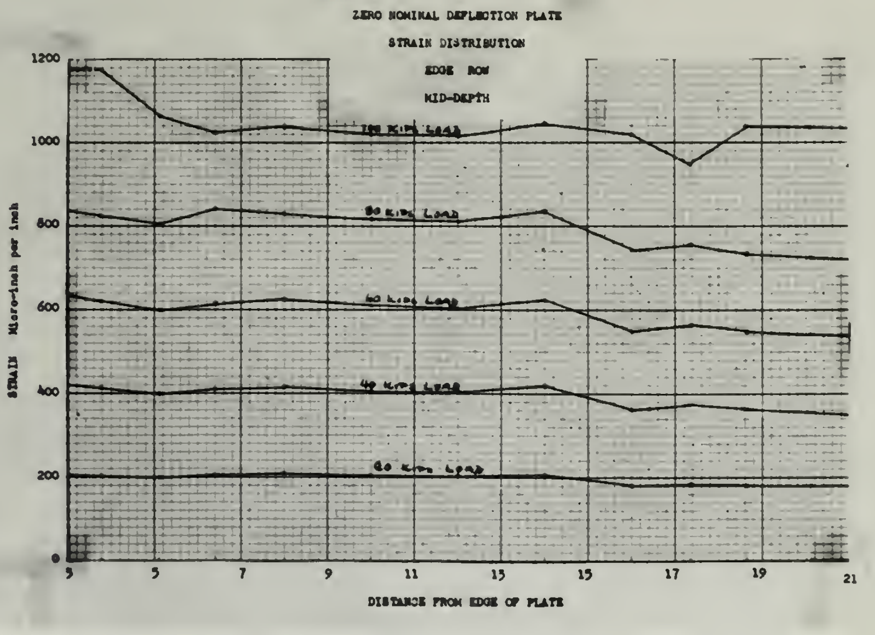
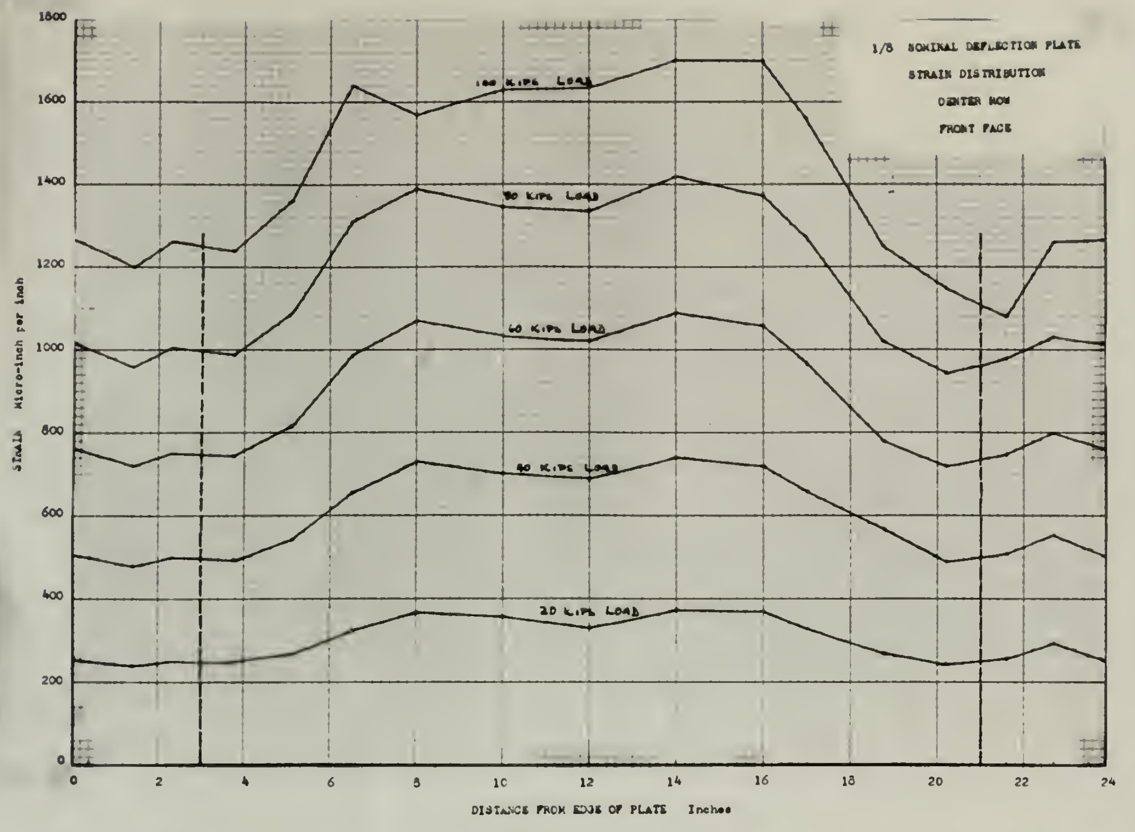
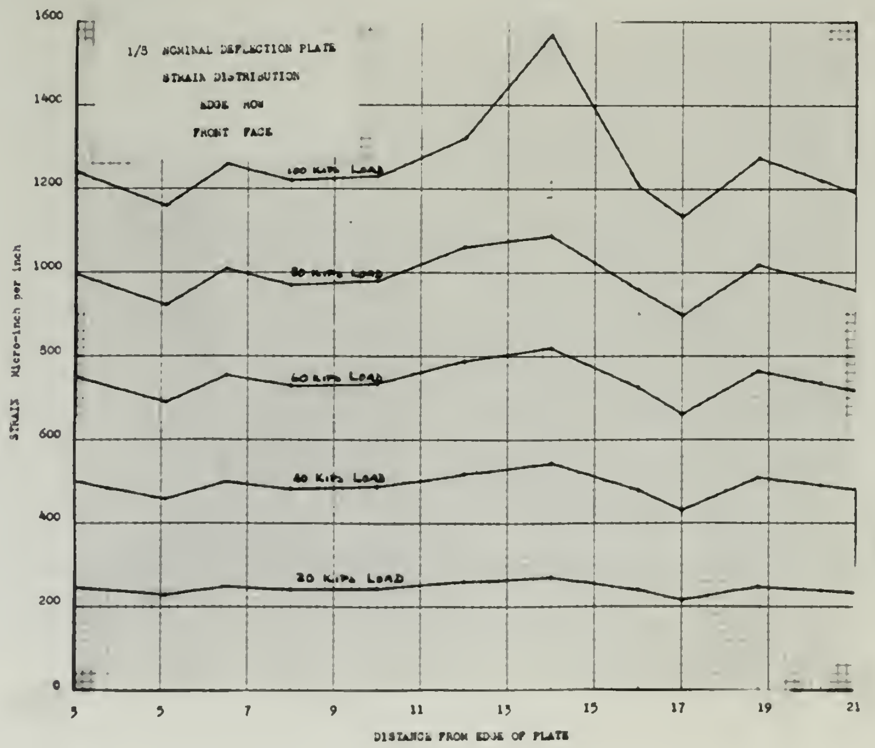
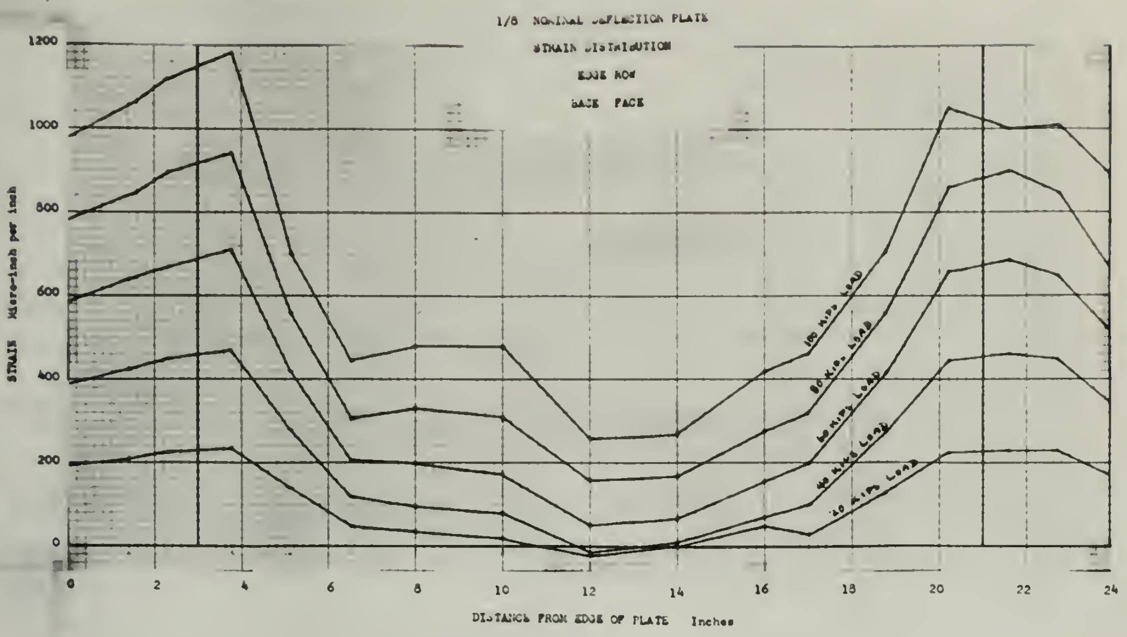

ZERO NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
MID-DEPTH
100 Kips Load
80 Kips Load
60 Kips Load
40 Kips Load
20 Kips Load
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
3
5
7
9
11
13
15
17
19
21
DISTANCE FROM EDGE OF PLATE

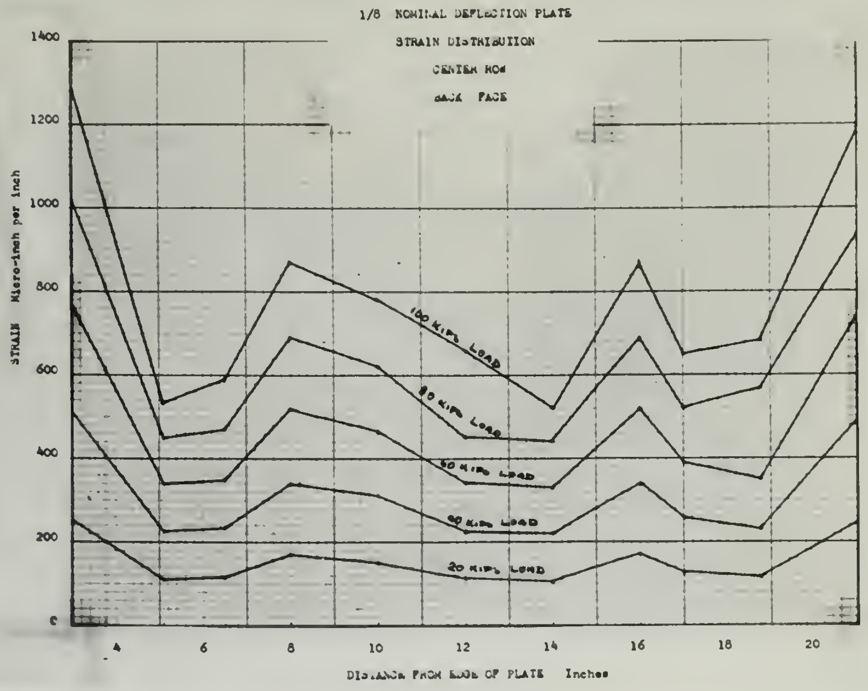
FIGURE XLVII



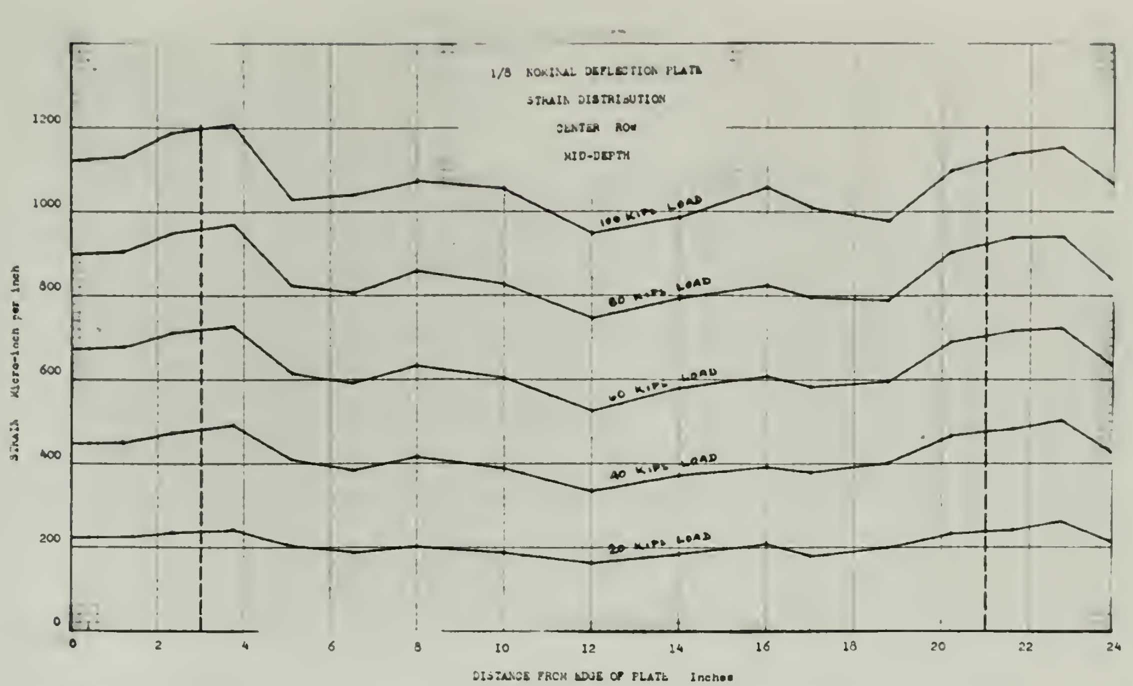


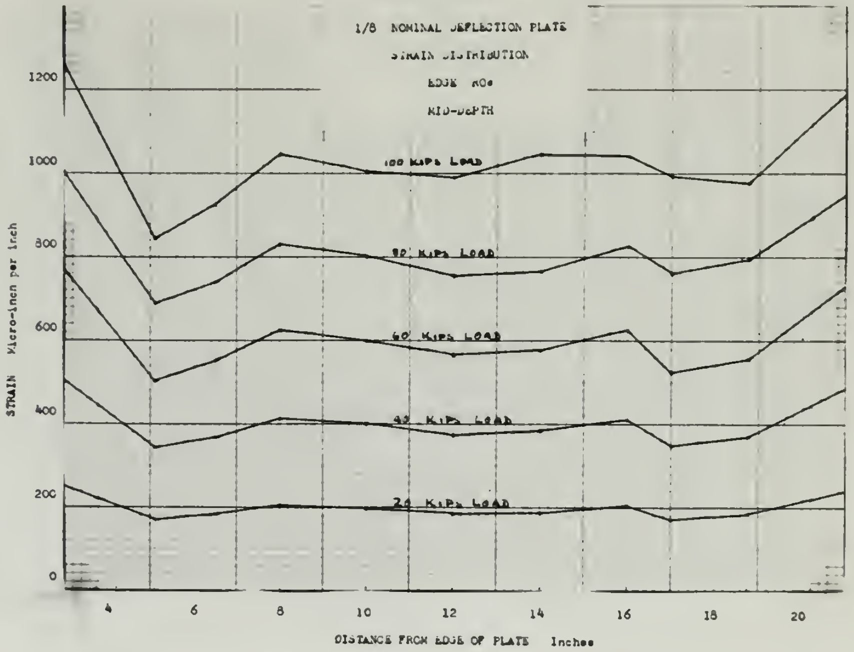
# FIGURE XLVIII



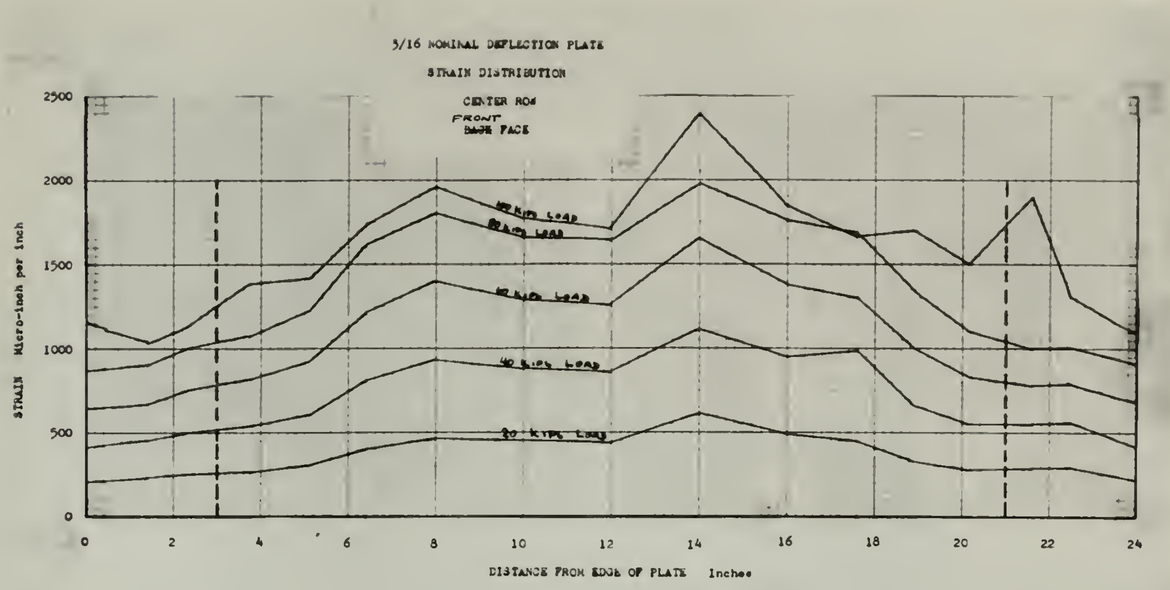


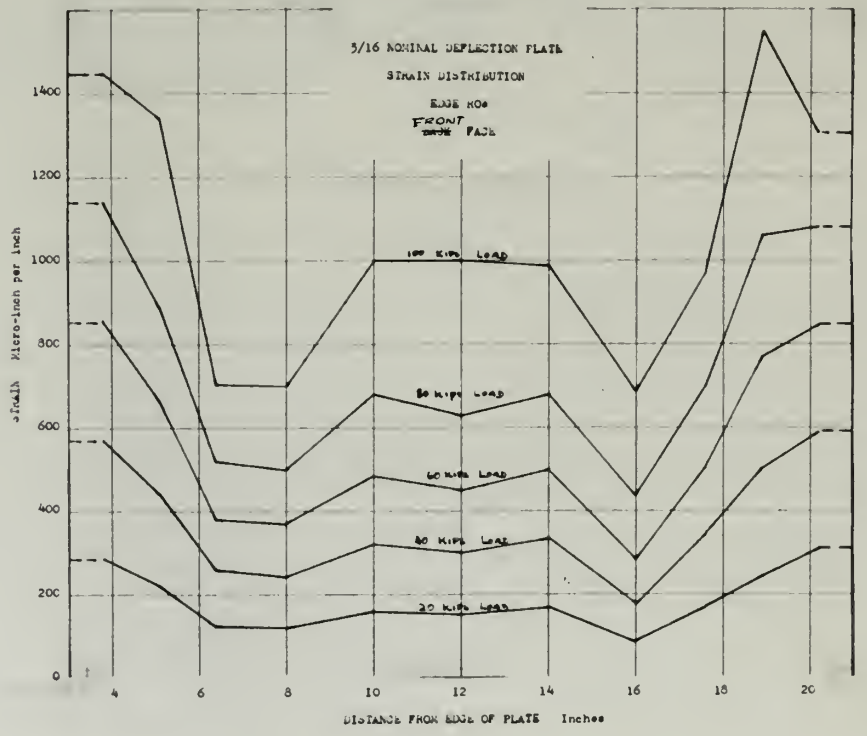
# FIGURE XLIX


1/8 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
CENTER ROW
MID-DEPTH
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE Inches

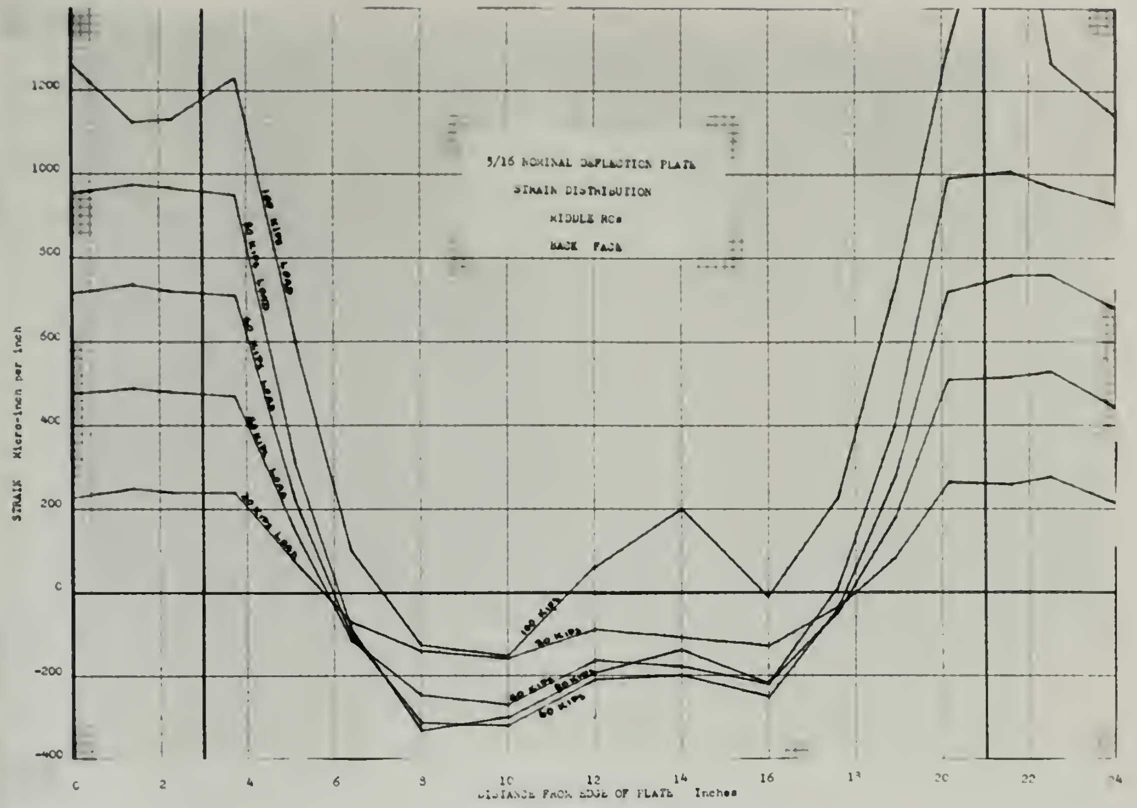

1/8 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
MID-DEPTH
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
4
6
8
10
12
14
16
18
20
DISTANCE FROM EDGE OF PLATE Inches

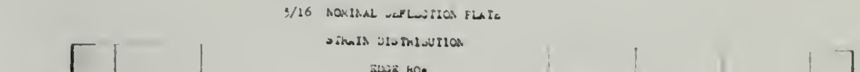
# FIGURE L


5/16 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
CENTER ROW
FRONT
~~BACK~~ FACE
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE Inches

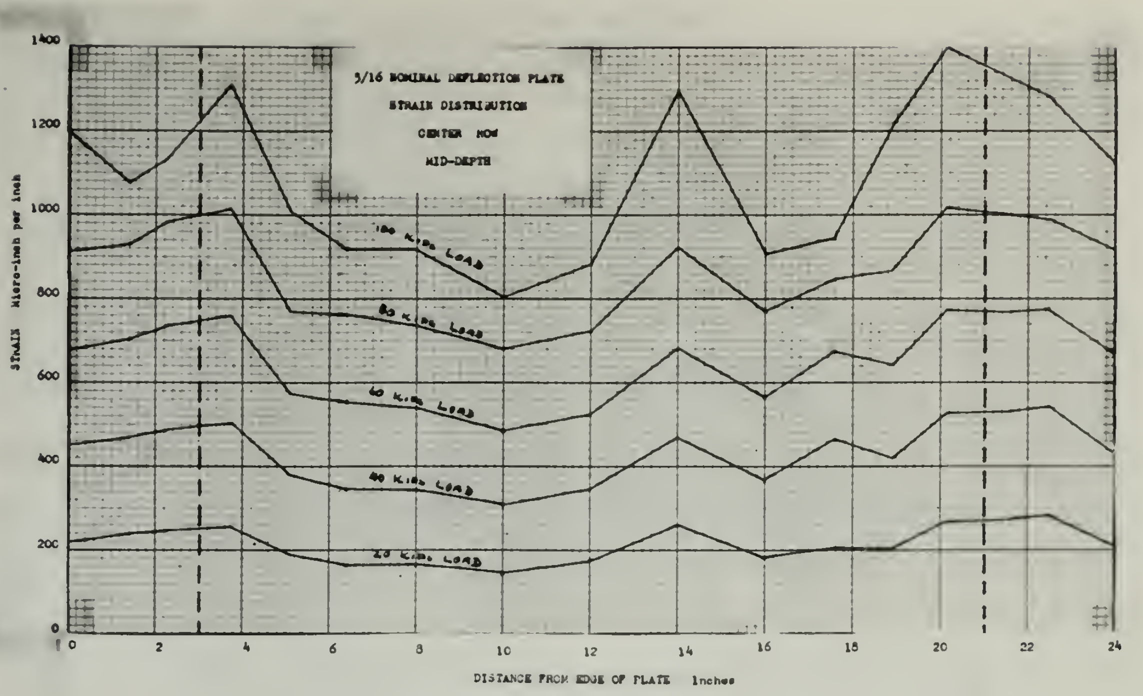

5/16 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
FRONT
~~BACK~~ FACE
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
1400
1200
1000
800
600
400
200
0
4
6
8
10
12
14
16
18
20
DISTANCE FROM EDGE OF PLATE Inches

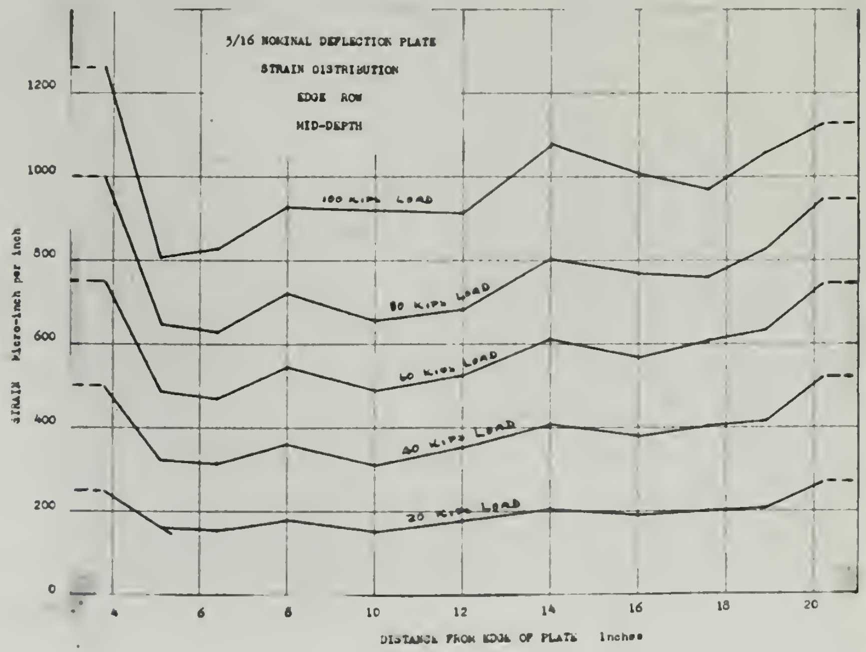
# FIGURE LI


5/16 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
MIDDLE ROW
BACK FACE
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
100 KIPS
80 KIPS
60 KIPS
40 KIPS
20 KIPS
STRAIN Micro-inch per inch
1200
1000
800
600
400
200
0
-200
-400
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE Inches

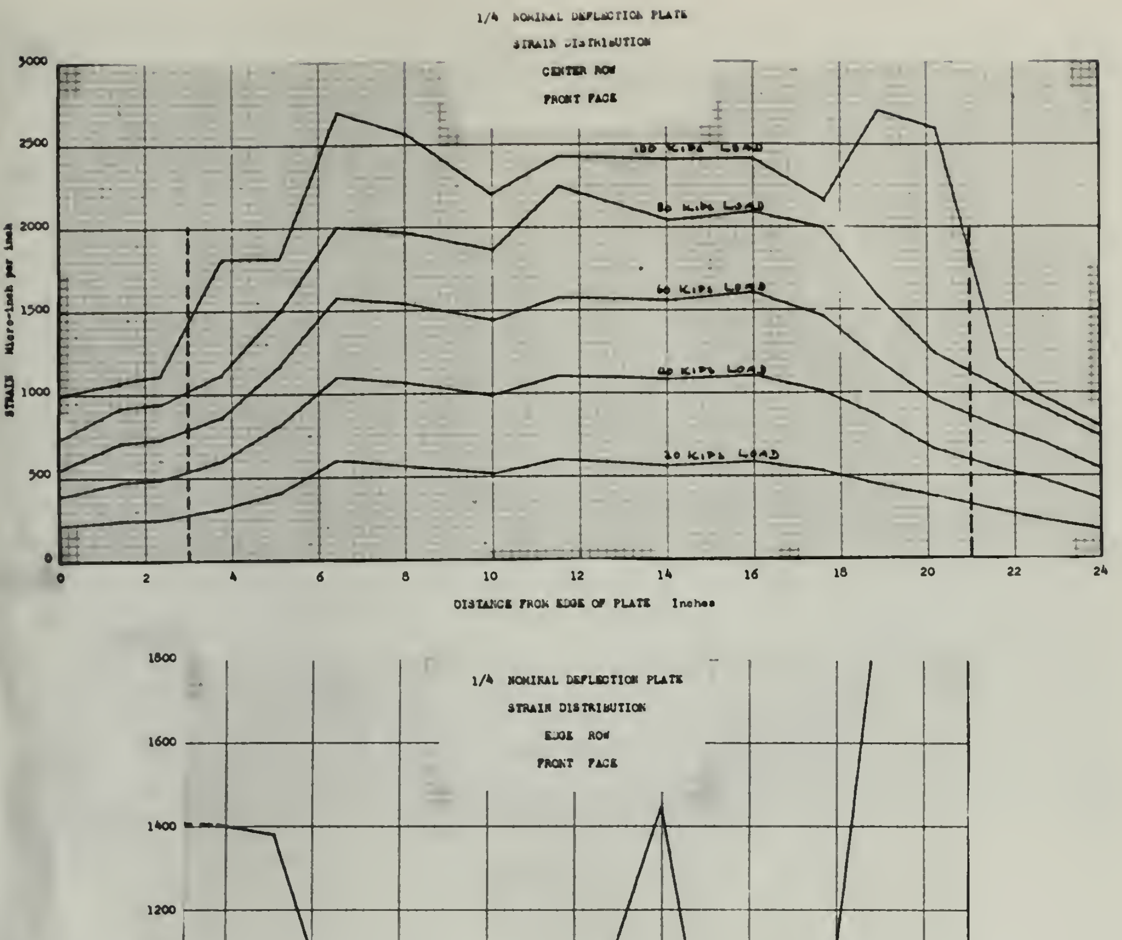

5/16 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
BACK FACE
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
1200
1000
800
600
400
200
0
4
6
8
10
12
14
16
18
20
DISTANCE FROM EDGE OF PLATE Inches

# FIGURE LII

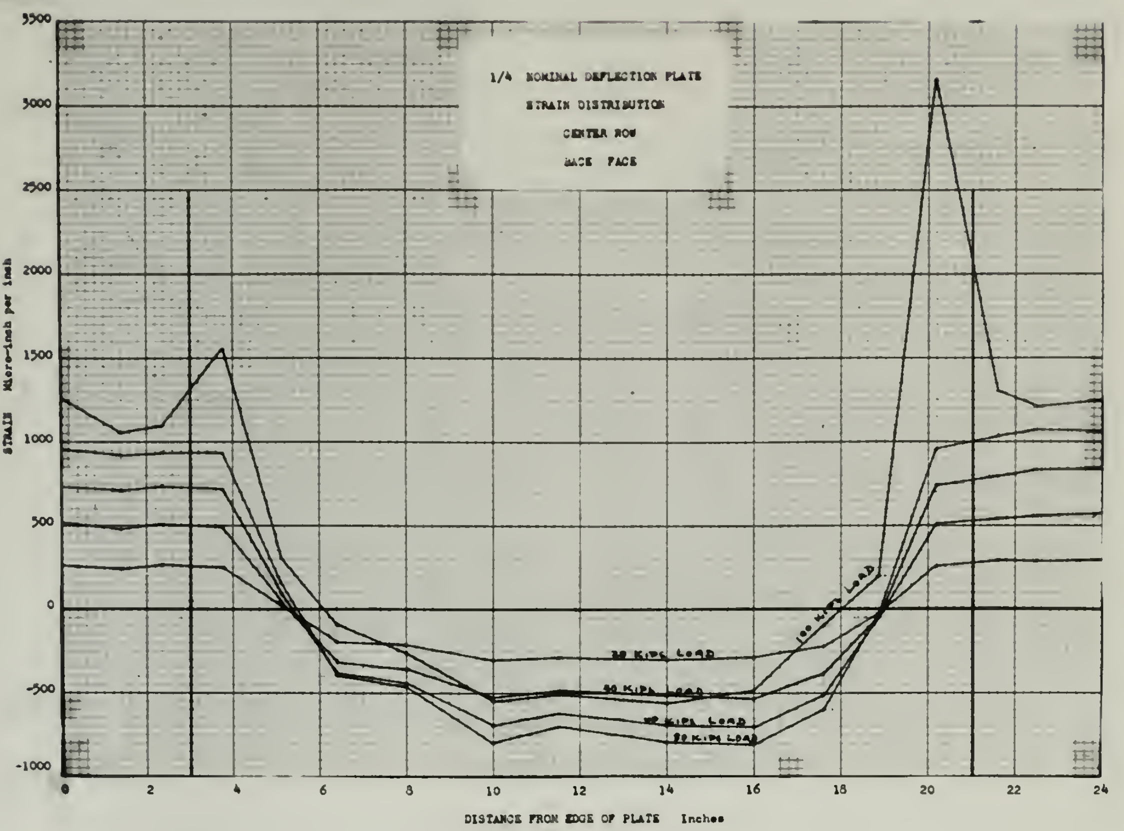

5/16 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
CENTER ROW
MID-DEPTH
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
1400
1200
1000
800
600
400
200
0
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE Inches

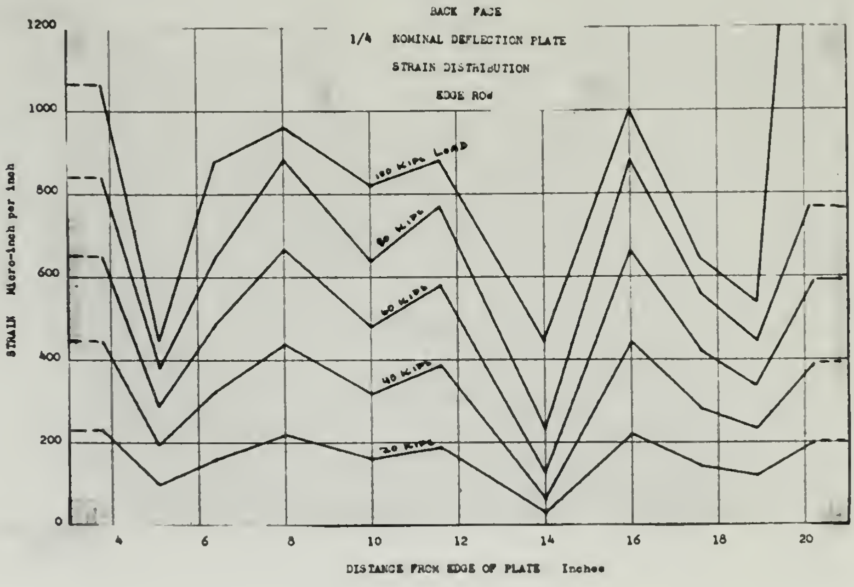

5/16 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
MID-DEPTH
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
1200
1000
800
600
400
200
0
4
6
8
10
12
14
16
18
20
DISTANCE FROM EDGE OF PLATE Inches

# FIGURE LIII


1/4 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
CENTER ROW
FRONT FACE
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
3000
2500
2000
1500
1000
500
0
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE Inches
1/4 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
FRONT FACE
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
1800
1600
1400
1200
1000
800
600
400
200
0
-200
4
6
8
10
12
14
16
18
20
DISTANCE FROM EDGE OF PLATE Inches

## FIGURE LIV


1/4 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
CENTER ROW
BACK FACE
STRAIN Micro-inch per inch
3500
3000
2500
2000
1500
1000
500
0
-500
-1000
100 KIPS LOAD
20 KIPS LOAD
40 KIPS LOAD
60 KIPS LOAD
80 KIPS LOAD
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE Inches


BACK FACE
1/4 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
STRAIN Micro-inch per inch
1200
1000
800
600
400
200
0
100 KIPS LOAD
80 KIPS
60 KIPS
40 KIPS
20 KIPS
4
6
8
10
12
14
16
18
20
DISTANCE FROM EDGE OF PLATE Inches

# FIGURE LV

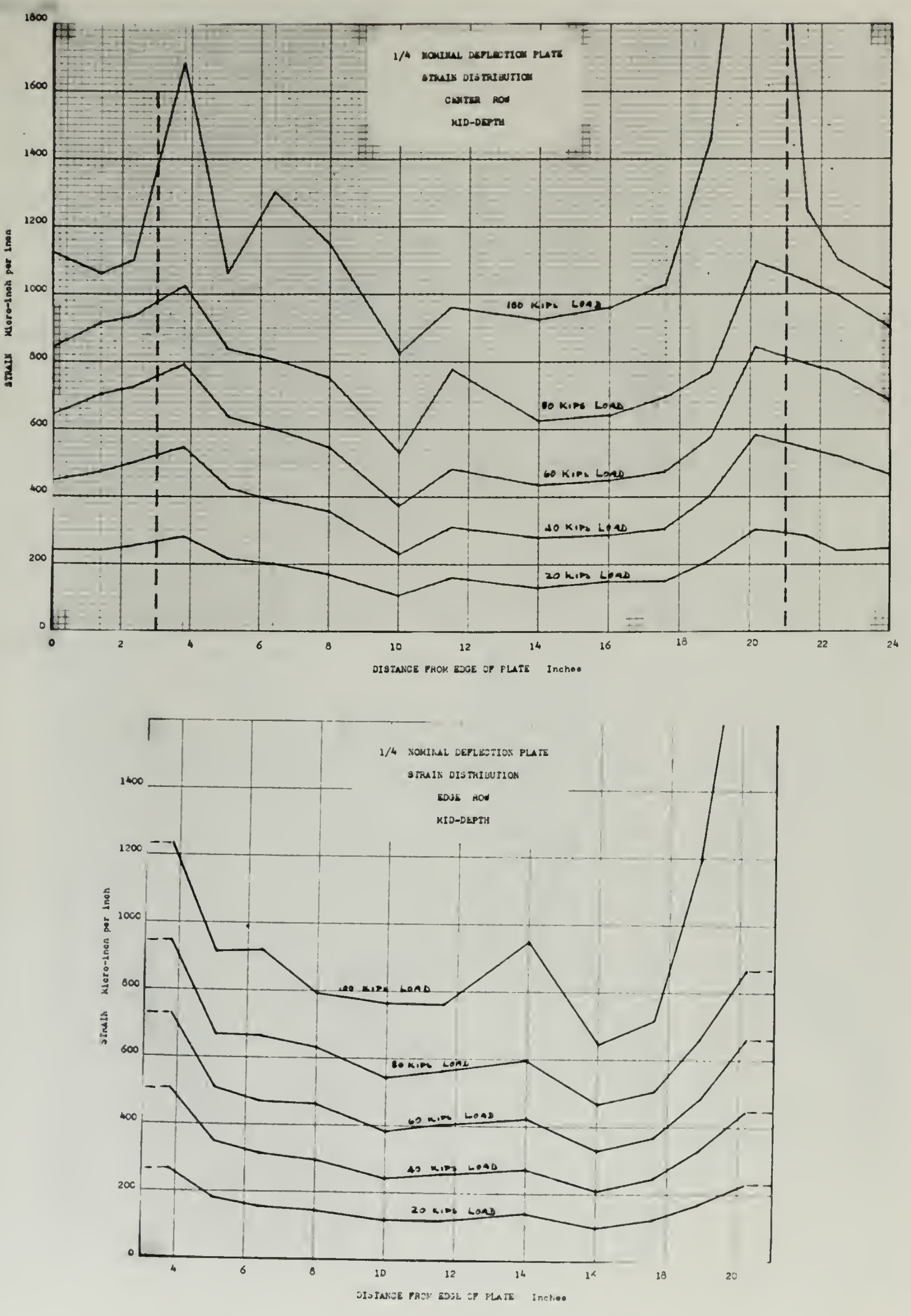
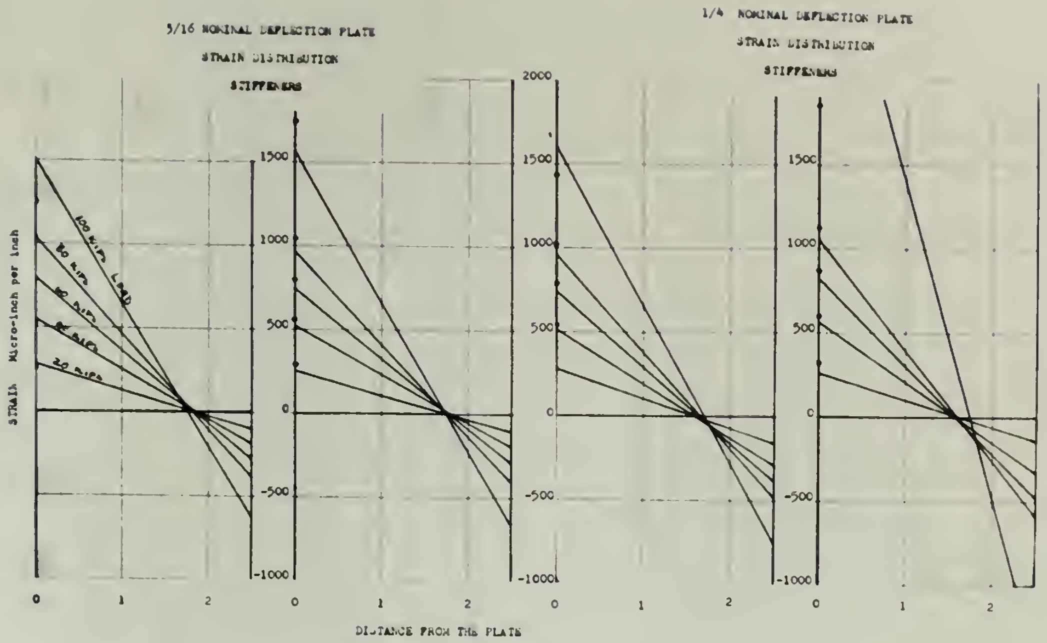
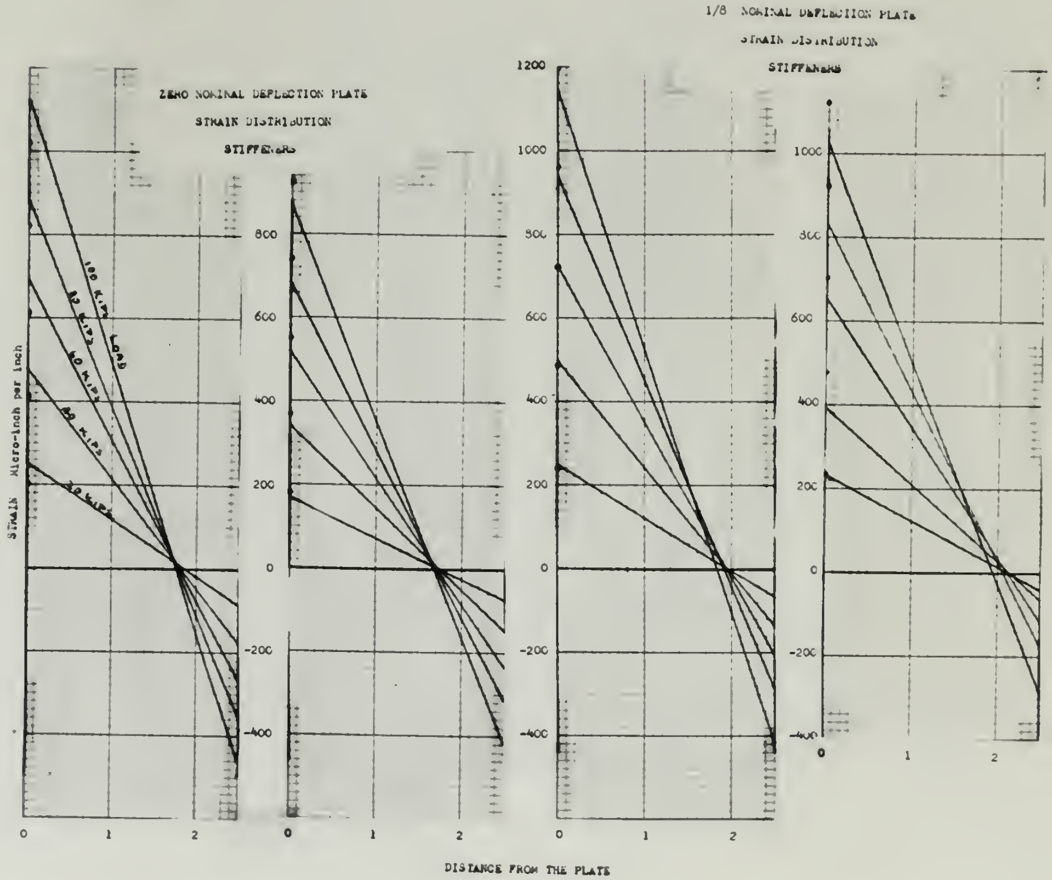
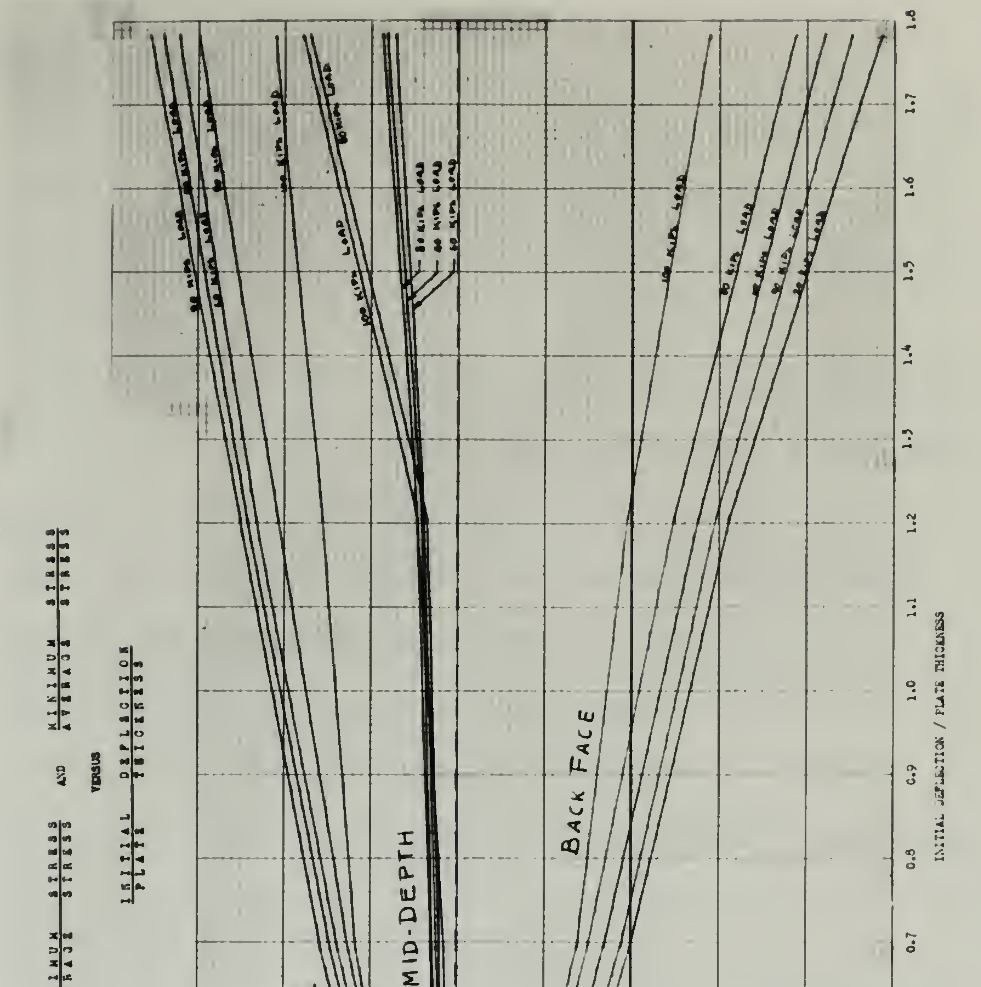

1/4 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
CENTER ROW
MID-DEPTH
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
1400
1600
1800
0
2
4
6
8
10
12
14
16
18
20
22
24
DISTANCE FROM EDGE OF PLATE Inches
1/4 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
EDGE ROW
MID-DEPTH
100 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
40 KIPS LOAD
20 KIPS LOAD
STRAIN Micro-inch per inch
0
200
400
600
800
1000
1200
1400
4
6
8
10
12
14
16
18
20
DISTANCE FROM EDGE OF PLATE Inches

FIGURE LVI


5/16 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
STIFFENERS
1/4 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
STIFFENERS
STRAIN Micro-inch per inch
100 KIPS LOAD
80 KIPS
60 KIPS
40 KIPS
20 KIPS
2000
1500
1000
500
0
-500
-1000
0
1
2
DISTANCE FROM THE PLATE


1/8 NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
STIFFENERS
ZERO NOMINAL DEFLECTION PLATE
STRAIN DISTRIBUTION
STIFFENERS
STRAIN Micro-inch per inch
100 KIPS LOAD
80 KIPS
60 KIPS
40 KIPS
20 KIPS
1200
1000
800
600
400
200
0
-200
-400
0
1
2
DISTANCE FROM THE PLATE

# FIGURE LVII


MAXIMUM STRESS / AVERAGE STRESS AND MINIMUM STRESS / AVERAGE STRESS
VERSUS
INITIAL DEFLECTION / PLATE THICKNESS
FRONT FACE
MID-DEPTH
BACK FACE
100 KIPS LOAD
90 KIPS LOAD
80 KIPS LOAD
60 KIPS LOAD
MAXIMUM STRESS / AVERAGE STRESS
MINIMUM STRESS / AVERAGE STRESS
INITIAL DEFLECTION / PLATE THICKNESS
3.0
2.5
2.0
1.5
1.0
0.5
0
-0.5
-1.0
-1.5
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8

# IV DISCUSSION OF THE RESULTS

## 4.1 Strain-Load Curves

The strain-load curves (Figures XV through XLIII) indicated that the strain-load relation is not linear for the structure tested. The departure from linear performance increases with the increase of initial deflection.

In the 3/16" nominal deflection plate and in the 1/4" nominal deflection plate there were measured strains greater than 2,400 micro-inch per inch for a load of 100 kips, particularly on the front face near the center of the plate. These strains indicate stress values greater than the yield stress of mild steel.

Therefore, it was considered that a strain distribution analysis would provide a more representative indication of what is actually taking place under load than an estimated stress distribution.

## 4.2 Strains Near the Transverse Stiffeners

The strain gages used to obtain the strain distribution were oriented in the direction of the principal strains indicated by the stress-coat analysis, as explained in section 2.5.

The crack pattern of the stress-coat started to form at a load of about 60 kips, and was completed by the time the load had increased to 80 kips.

It is believed that the orientation of the principal strains changed with the variation of the load because the magnitude of the deflection of the panel probably changed with the load. Therefore, the

observations made along the row of strain gages near the stiffeners have a limited significance. Future reference herein to strains should be construed to mean strains measured along the transverse centerline. It should be realized that the strains measured in the row of strain gages near the transverse stiffeners were always lower in value than the maximum strain measured along the transverse centerline even at the loads of 60 to 80 kips; therefore, there is no loss of generality because it is desired to relate a maximum stress to deflection only.

### 4.3 Strains at the Transverse Centerline of the Panel

The crack pattern of the stress coat for the four plates at the transverse centerline of the panel (Figures IX through XII) had an orientation parallel to the transverse stiffeners, indicating that the orientation of the principal strains at the transverse centerline of the panel did not change with the initial deflection of the plate, and that the orientation of the principal strains was parallel to the longitudinal axis of the specimen.

By symmetry, the direction of the principal strains should be parallel to the longitudinal axis of the specimen.

Therefore, the strains measured with the strain gages at the transverse centerline of the panel, which were installed with their axes oriented parallel to the longitudinal axis of the specimen, are actually the principal strains.

### 4.4 Strain Distribution in the Unstiffened Side of the Plate

The curves of strain distribution on the unstiffened side of

the plate (Figures XLIV, XLVII, L, and LIII) indicated two maximum strain values at about the quarter points of the transverse centerline of the panel.

## 4.5 Strain Distribution in the Stiffened Side of the Plate

The curves of strain distribution in the stiffened side of the plate (Figures XLV, XLVIII, LI, and LIV) indicated minimum strain values at about the center of the panel.

## 4.6 Strain Distribution in the Mid-Depth of the Plate

The curves of strain distribution at the mid-depth of the plate (Figures XLVI, XLIX, LII, and LV) indicated two maximum strain values at the transverse centerline of the panel near to the stiffeners and a minimum strain value at the center of the panel.

## 4.7 Strain Distribution in the Stiffeners

The strains measured in the stiffeners were always smaller than the average strain in the plate. This indicated that the stiffeners were not sharing the load with the plate, which condition resulted from the load not being applied in line with the position of the neutral axis of the test section. For this reason, a shear load between the plate and the stiffeners existed. The stiffeners were loaded in tension at the bottom edge which caused a bending moment effect on the stiffeners, as can be observed in Figure LVI. The tendency of the shear to produce a compressive effect on the plate reduced the tensile strain in the plate near the stiffeners. Therefore it is believed that the strains in the portion of the plate adjacent to the stiffeners would have a higher value than the measured one if the stiffeners were sharing properly the applied load.

To reduce the shearing force between the plate and the stiffeners the specimens would have to be redesigned. By using stiffeners on both sides of the plate and very stiff members welded at the ends of the test section, an even distribution of load between the stiffeners and the plate would be obtained.

### 4.8 Strain-Deflection Relationship

Figure LVII shows that the ratios of the maximum stress in the unstiffened side of the plate to the average stress in the plate, of the minimum stress in the stiffened side of the plate to the average stress in the plate, and of the maximum stress in the mid-depth of the plate to the average stress in the plate varied almost linearly with the ratios of the initial deflection to the plate thickness within the elastic region of the material.

The values of the stress ratios mentioned above approach unity as the applied load increases within the elastic region of the material. This effect may be explained if it is realized that the deflection of the panel decreases as the applied load increases.

It should be mentioned that for a load of 80 kips in the 3/16" and in the 1/4" nominal deflection plates and for a load of 100 kips in all of the plates, the stresses exceeded the yield point of the material, as can be observed in the load-strain curves (Figures XV through XLIII). For this reason, the stress ratio curves of Figure LVII actually indicate for all values of the deflection-thickness ratio and for the load of 80 kips for the range deflection-thickness ratios greater than 1.2.

### 4.9 Section of the Plate Adjacent to the Longitudinal Stiffeners

When the tensile load was applied to the test sections with initial deflection, the maximum stresses in the mid-depth of the plate were produced at the region of the panel adjacent to the longitudinal stiffeners. The material at the center of the panel was initially curved, while the material adjacent to the longitudinal stiffeners was straight; therefore, when the tensile load was applied, the curved fibers were unable to assume a strictly proportionate share of the load.

For an initial-deflection-thickness ratio of 1.5, and a load of 60 kips (8 tons per square inch or 18000 pounds per square inch of average stress in the plate), the claculated ratio of the maximum stress in the mid-depth of the plate at the region adjacent to the longitudinal stiffeners to the average stress in the plate was 1.275. Because the stiffeners did not share the load with the plate, it is believed that this value should be larger. This stress ratio is the stress concentration factor produced by the initial deflection of the panel.

### 4.10 Center Section of the Panel

When the tensile load was applied on the test sections with initial deflection, the maximum stresses were produced at the center of the panel in the unstiffened side of the plate, and the minimum values of the tensile strain were obtained in the same region in the stiffened side. The center of the panel was by a direct tensile load and by a bending load due to the deflection. The sum of these loads caused a high tensile stress in the concave side of the panel (unstiffened face), and a low tensile stress, some times negative (compressive stress) in the convex side of the plate (stiffened face).

For an initial-deflection-plate thickness ratio of 1.5, and a load of 60 kips (about 8 tons persquare inch or 18000 pounds per square inch of average stress in the plate), the calculated ratio of the maximum stress at the center of the panel in the unstiffened (concave) side of the plate to the average stress in the plate was 2.39. Because the stiffeners did not share the load with the plate, it is believed that the direct tensile stress at the center of the plate would be smaller. However, the bending moment would be larger. The net effect cannot be estimated. The bending moment would be larger, because, if the stiffeners worked fully, the neutral axis of the section (or line of application of the load) would be at a larger distance from the plate at the center of the panel. This calculated stress ratio is the stress concentration factor produced by the initial deflection of the panel.

The stress concentration factor for the unstiffened side of the plate in the central region of the panel is much higher than that for the region of the plate adjacent to the longitudinal stiffeners. Considering the big difference between these two stress concentration factors, it is believed that the stress concentration factor for the central region of the panel would still be the largest one even if the stiffeners properly shared the load.

This stress concentration at the center of the unstiffened side combined with alternation of stresses, is a sufficient cause to produce surface cracks in the plate, which in turn increase the stress concentration causing the complete failure of the plate.

# V CONCLUSIONS

5.1 In the unstiffened side of the deflected panels, the maximum stresses are produced at the quarter points of the transverse centerline of the panel.

5.2 In the stiffened side of the deflected panels, the minimum stresses are produced at the center of the panel.

5.3 In the mid-depth of the deflected panels, the maximum stresses are produced in a region adjacent to the longitudinal stiffeners at the transverse centerline of the panel, and the minimum stresses at the center of the panel.

5.4 The ratios of the maximum to the average stress values increase almost linearly with the increase of initial-deflection-plate-thickness ratio within the elastic region of the material. The ratios of the minimums to the average stress values decrease almost linearly with the increase of the initial-deflection-plate-thickness ratio within the elastic region of the material.

5.5 The ratios of the maximums to the average stress values and of the minimums to the average stress values approach unity as the applied load increases within the elastic region of the material.

5.6 The high stress concentrations in the unstiffened side of the plate (concave side) caused by large initial deflections, combined with alternation of stresses, produce surface cracks in the plate.

## VI RECOMMENDATIONS

6.1 To reduce the shearing force between the plate and the stiffeners, the specimen should be redesigned using stiffeners on both sides of the plate and very stiff members welded at the ends of the test section so that an even distribution of the load between the stiffeners and the plate would result.

6.2 Investigations should be continued with different aspect ratios until sufficient data is compiled to specify a maximum allowable deflection of panels.

# VII APPENDIX

# APPENDIX A

## TEST DATA

## TABLE I
## DATA SHEET
## INITIAL DEFLECTION READINGS
## PLATE OF ZERO NOMINAL DEFLECTION

| Station | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 1 | 5 | 6 | 9 | 12 | 14 | 13 | 7 | 0 |
| 2 | 2 | 4 | 5 | 9 | 13 | 15 | 19 | 19 | 17 | 13 | 11 |
| 3 | 1 | 3 | 3 | 6 | 8 | 9 | 15 | 17 | 16 | 15 | 14 |
| 4 | -5 | -0 | -2 | -1 | 1 | 3 | 8 | 12 | 15 | 17 | 16 |
| 5 | -7 | -5 | -9 | -7 | -4 | -2 | 0 | 6 | 8 | 12 | 14 |
| 6 | -11 | -10 | -14 | -12 | -7 | -11 | -7 | -4 | 3 | 8 | 11 |
| 7 | -15 | -13 | -17 | -15 | -10 | -9 | -13 | -4 | 1 | 6 | 9 |
| 8 | -20 | -13 | -14 | -9 | -6 | 1 | 11 | 16 | 10 | 7 | 7 |
| 9 | -21 | -7 | -2 | -1 | 0 | 4 | 14 | 18 | 16 | 8 | 2 |
| 10 | -24 | 1 | 11 | 5 | 4 | 6 | 14 | 18 | 14 | 7 | 0 |
| 11 | -26 | -8 | 2 | 5 | 6 | 7 | 12 | 14 | 13 | 8 | 0 |
| 12 | -26 | -13 | -7 | -1 | 2 | 5 | 10 | 14 | 16 | 11 | -1 |
| 13 | -33 | -21 | -15 | -7 | -3 | 0 | 6 | 10 | 13 | 6 | -7 |
| 14 | -37 | -27 | -22 | -13 | -8 | -6 | 1 | 6 | 6 | 0 | -10 |
| 15 | -39 | -32 | -26 | -18 | -13 | -10 | -4 | 1 | -1 | -5 | -10 |
| 16 | -39 | -34 | -32 | -24 | -18 | -13 | -9 | -4 | -5 | -8 | -10 |
| 17 | -44 | -40 | -37 | -29 | -23 | -19 | -11 | -8 | -8 | -9 | -9 |
| 18 | -53 | -44 | -40 | -32 | -27 | -22 | -14 | -9 | -10 | -9 | -7 |
| 19 | -51 | -46 | -43 | -34 | -29 | -24 | -15 | -10 | -11 | -8 | -6 |
| 20 | -55 | -49 | -44 | -36 | -29 | -25 | -15 | -10 | -9 | -8 | -6 |
| 21 | -55 | -49 | -46 | -37 | -30 | -25 | -14 | -9 | -8 | -6 | -3 |
| 22 | -55 | -51 | -48 | -39 | -30 | -25 | -14 | -8 | -7 | -4 | -3 |
| 23 | -61 | -55 | -49 | -40 | -30 | -25 | -15 | -7 | -5 | -3 | -2 |
| 24 | -64 | -57 | -52 | -42 | -31 | -25 | -16 | -8 | -6 | -3 | 1 |
| 25 | -64 | -57 | -52 | -42 | -33 | -27 | -18 | -11 | -9 | -4 | 0 |
| 26 | -58 | -58 | -50 | -50 | -32 | -27 | -19 | -15 | -12 | -8 | -5 |
| 27 | -52 | -48 | -46 | -26 | -28 | -25 | -22 | -18 | -15 | -10 | -6 |
| 28 | -47 | -42 | -42 | -36 | -25 | -26 | -22 | -19 | -16 | -10 | -6 |
| 29 | -37 | -34 | -39 | -35 | -27 | -30 | -25 | -20 | -16 | -9 | -5 |
| 30 | -29 | -28 | -33 | -31 | -26 | -25 | -25 | -17 | -12 | -7 | -2 |
| 31 | -22 | -21 | -27 | -25 | -21 | -19 | -13 | -11 | -9 | -7 | -1 |
| 32 | -16 | -14 | -20 | -19 | -19 | -18 | -11 | -6 | -4 | -3 | -1 |
| 33 | -9 | -9 | -13 | -12 | -14 | -13 | -8 | -1 | 1 | 1 | 0 |
| 34 | -3 | -1 | -4 | -5 | -6 | -18 | -2 | 6 | 7 | 8 | 6 |
| 34 | 0 | 7 | 7 | 6 | 1 | -2 | 3 | 13 | 14 | 14 | 6 |

1. Readings in thousandth of an inch
2. Station ½ inch spaced

## TABLE I (continued)
## DATA SHEET
## INITIAL DEFLECTION READINGS
## PLATE OF 1/8" NOMINAL DEFLECTION

| Station | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -6 | -9 | -15 | -17 | -13 | -7 | -3 | -1 | -2 | 0 |
| 1 | 5 | 5 | 14 | 12 | 15 | 15 | 17 | 22 | 19 | 8 | 4 |
| 2 | 8 | 21 | 47 | 59 | 52 | 49 | 57 | 66 | 60 | 34 | 9 |
| 3 | 13 | 37 | 64 | 76 | 79 | 80 | 89 | 67 | 85 | 58 | 18 |
| 4 | 17 | 56 | 78 | 91 | 102 | 104 | 104 | 99 | 92 | 53 | 15 |
| 5 | 17 | 63 | 89 | 95 | 100 | 99 | 98 | 95 | 80 | 44 | 11 |
| 6 | 15 | 58 | 86 | 93 | 97 | 98 | 99 | 93 | 83 | 48 | 10 |
| 7 | 7 | 27 | 76 | 87 | 93 | 97 | 100 | 95 | 95 | 62 | 10 |
| 8 | 8 | 40 | 69 | 83 | 93 | 91 | 97 | 98 | 89 | 54 | 9 |
| 9 | 9 | 35 | 66 | 79 | 85 | 89 | 98 | 100 | 95 | 50 | 5 |
| 10 | 10 | 35 | 62 | 78 | 83 | 83 | 94 | 98 | 99 | 49 | 6 |
| 11 | 11 | 36 | 72 | 83 | 93 | 89 | 93 | 96 | 87 | 50 | 6 |
| 12 | 12 | 41 | 74 | 88 | 93 | 86 | 92 | 94 | 81 | 50 | 9 |
| 13 | 10 | 36 | 70 | 87 | 88 | 79 | 87 | 85 | 73 | 33 | [illegible] |
| 14 | 7 | 34 | 68 | 85 | 84 | 78 | 85 | 83 | 69 | 30 | -2 |
| 15 | 5 | 35 | 73 | 83 | 87 | 82 | 92 | 90 | 73 | 33 | -4 |
| 16 | -3 | 35 | 64 | 76 | 85 | 86 | 99 | 92 | 76 | 31 | -8 |
| 17 | -11 | 26 | 58 | 73 | 78 | 84 | 95 | 90 | 76 | 31 | -13 |
| 18 | -17 | 22 | 54 | 73 | 82 | 85 | 90 | 87 | 86 | 35 | -14 |
| 19 | -26 | 18 | 51 | 72 | 83 | 83 | 86 | 83 | 78 | 38 | -14 |
| 20 | -23 | 20 | 62 | 78 | 78 | 85 | 82 | 79 | 77 | 41 | -13 |
| 21 | -22 | 24 | 54 | 68 | 76 | 78 | 74 | 70 | 73 | 40 | -12 |
| 22 | -16 | 25 | 57 | 74 | 78 | 79 | 80 | 78 | 75 | 35 | -11 |
| 23 | -17 | 20 | 52 | 68 | 77 | 82 | 84 | 78 | 69 | 27 | -13 |
| 24 | -16 | 15 | 47 | 69 | 77 | 78 | 83 | 77 | 67 | 21 | -13 |
| 25 | -16 | 14 | 48 | 66 | 73 | 71 | 81 | 76 | 66 | 22 | -13 |
| 26 | -15 | 20 | 51 | 66 | 73 | 72 | 77 | 76 | 66 | 23 | -12 |
| 27 | -12 | 29 | 58 | 72 | 76 | 82 | 80 | 79 | 73 | 29 | -6 |
| 28 | -10 | 35 | 67 | 76 | 74 | 74 | 79 | 81 | 82 | 35 | -2 |
| 29 | -6 | 41 | 64 | 76 | 80 | 85 | 84 | 87 | 84 | 36 | -1 |
| 30 | -3 | 37 | 68 | 80 | 79 | 86 | 83 | 93 | 81 | 36 | 2 |
| 31 | -1 | 46 | 73 | 88 | 83 | 87 | 89 | 94 | 80 | 44 | 11 |
| 32 | 4 | 53 | 64 | 78 | 75 | 77 | 80 | 77 | 75 | 50 | 20 |
| 33 | 2 | 30 | 43 | 50 | 51 | 54 | 60 | 56 | 57 | 37 | 16 |
| 34 | -1 | 9 | 39 | 23 | 22 | 26 | 31 | 34 | 36 | 26 | 18 |
| 35 | -2 | -3 | 2 | 0 | -10 | -8 | 6 | 24 | 31 | 26 | 25 |
| 36 | 0 | -6 | -4 | -4 | -5 | -4 | 0 | 7 | 9 | 10 | 14 |

# TABLE I (continued)
## DATA SHEET
## INITIAL DEFLECTION READINGS
## PLATE OF 3/16" NOMINAL DEFLECTION

| Station | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | -3 | -6 | -8 | -8 | -7 | -6 | -4 | -4 | 0 |
| 1 | 2 | 24 | 34 | 26 | 24 | 28 | 22 | 20 | 18 | 6 | -3 |
| 2 | 10 | 48 | 80 | 81 | 81 | 80 | 79 | 69 | 56 | 30 | 4 |
| 3 | 8 | 53 | 89 | 111 | 118 | 120 | 127 | 107 | 88 | 43 | 2 |
| 4 | 6 | 55 | 98 | 121 | 136 | 134 | 136 | 120 | 101 | 49 | -3 |
| 5 | 4 | 56 | 97 | 125 | 138 | 144 | 143 | 128 | 109 | 48 | -11 |
| 6 | 4 | 57 | 95 | 119 | 127 | 137 | 135 | 126 | 112 | 47 | -12 |
| 7 | 8 | 62 | 100 | 118 | 126 | 131 | 128 | 120 | 97 | 31 | -32 |
| 8 | 10 | 64 | 102 | 123 | 128 | 135 | 135 | 116 | 78 | 16 | -38 |
| 9 | 11 | 61 | 101 | 124 | 133 | 142 | 140 | 113 | 76 | 11 | -44 |
| 10 | 12 | 60 | 102 | 125 | 134 | 140 | 133 | 115 | 81 | 12 | -46 |
| 11 | 17 | 62 | 102 | 124 | 137 | 139 | 132 | 117 | 80 | 15 | -46 |
| 12 | 21 | 70 | 108 | 122 | 139 | 141 | 134 | 115 | 76 | 8 | -50 |
| 13 | 25 | 87 | 127 | 141 | 150 | 147 | 136 | 116 | 83 | 10 | -51 |
| 14 | 32 | 108 | 139 | 146 | 150 | 145 | 135 | 113 | 82 | 15 | -56 |
| 15 | 33 | 103 | 138 | 140 | 147 | 143 | 135 | 109 | 82 | 15 | -59 |
| 16 | 31 | 111 | 135 | 135 | 143 | 145 | 136 | 114 | 83 | 7 | -64 |
| 17 | 33 | 105 | 130 | 135 | 141 | 143 | 140 | 112 | 82 | 7 | -66 |
| 18 | 33 | 104 | 127 | 135 | 140 | 139 | 136 | 110 | 79 | 7 | -66 |
| 19 | 31 | 101 | 127 | 136 | 139 | 137 | 127 | 154 | 71 | 1 | -66 |
| 20 | 30 | 91 | 124 | 131 | 134 | 132 | 118 | 93 | 64 | -7 | -65 |
| 21 | 29 | 88 | 120 | 127 | 131 | 127 | 115 | 88 | 51 | -11 | -66 |
| 22 | 28 | 81 | 112 | 124 | 130 | 131 | 119 | 87 | 51 | -9 | -65 |
| 23 | 27 | 75 | 109 | 124 | 133 | 138 | 123 | 96 | 61 | 6 | -58 |
| 24 | 27 | 72 | 109 | 119 | 129 | 133 | 124 | 106 | 66 | 6 | -56 |
| 25 | 25 | 66 | 96 | 126 | 130 | 127 | 127 | 99 | 57 | 2 | -50 |
| 26 | 24 | 62 | 94 | 113 | 123 | 127 | 126 | 99 | 52 | -6 | -52 |
| 27 | 25 | 64 | 99 | 118 | 125 | 124 | 118 | 98 | 52 | -10 | -53 |
| 28 | 26 | 65 | 98 | 113 | 125 | 122 | 111 | 86 | 51 | -10 | -50 |
| 29 | 26 | 62 | 90 | 110 | 121 | 117 | 103 | 79 | 47 | -8 | -46 |
| 30 | 26 | 58 | 84 | 105 | 113 | 109 | 97 | 78 | 50 | -1 | -41 |
| 31 | 25 | 54 | 78 | 92 | 97 | 99 | 93 | 76 | 60 | 9 | -32 |
| 32 | 23 | 46 | 66 | 78 | 85 | 89 | 81 | 64 | 52 | 15 | -25 |
| 33 | 20 | 36 | 55 | 67 | 68 | 69 | 54 | 44 | 38 | 6 | -20 |
| 34 | 13 | 22 | 37 | 45 | 42 | 39 | 27 | 14 | 13 | -5 | -19 |
| 35 | 7 | 7 | 6 | 3 | 0 | 1 | -6 | -11 | -10 | -15 | -18 |
| 36 | 0 | -4 | -7 | -13 | -16 | -17 | -20 | -24 | -19 | -21 | -18 |

### TABLE I (continued)
### DATA SHEET
### INITIAL DEFLECTION READINGS
### PLATE OF 1/4" NOMINAL DEFLECTION

| Station | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 2 | 0 | -2 | -5 | -6 | -9 | -11 | -7 | -7 | -7 | -4 | 0 |
| 1 | 0 | 1 | 7 | 13 | 11 | 7 | 4 | 2 | 1 | 4 | 2 | 3 | -1 |
| 2 | -1 | 5 | 20 | 36 | 40 | 47 | 38 | 31 | 22 | 14 | 6 | 4 | -3 |
| 3 | -6 | 4 | 31 | 58 | 78 | 77 | 68 | 62 | 44 | 25 | 12 | 3 | -6 |
| 4 | -14 | 1 | 31 | 77 | 107 | 111 | 111 | 91 | 63 | 37 | 17 | -1 | -15 |
| 5 | -21 | -4 | 48 | 98 | 117 | 124 | 131 | 105 | 74 | 48 | 22 | -5 | -21 |
| 6 | -27 | -10 | 57 | 104 | 119 | 128 | 138 | 115 | 83 | 57 | 28 | -12 | -30 |
| 7 | -27 | -15 | 53 | 100 | 116 | 137 | 136 | 137 | 81 | 50 | 20 | -18 | -38 |
| 8 | -27 | -16 | 43 | 100 | 123 | 144 | 140 | 119 | 84 | 50 | 16 | -24 | -45 |
| 9 | -25 | -19 | 39 | 95 | 127 | 146 | 141 | 127 | 100 | 52 | 19 | -28 | -48 |
| 10 | -26 | -17 | 35 | 93 | 131 | 147 | 146 | 136 | 115 | 77 | 24 | -32 | -59 |
| 11 | -24 | -13 | 39 | 99 | 138 | 153 | 164 | 155 | 126 | 89 | 30 | -33 | -58 |
| 12 | -27 | -14 | 45 | 106 | 142 | 156 | 176 | 168 | 136 | 95 | 35 | -36 | -62 |
| 13 | -26 | -11 | 62 | 117 | 147 | 165 | 183 | 180 | 146 | 104 | 48 | -36 | -67 |
| 14 | -25 | -3 | 81 | 126 | 151 | 171 | 189 | 189 | 153 | 107 | 52 | -27 | -71 |
| 15 | -26 | -5 | 74 | 141 | 151 | 172 | 193 | 194 | 152 | 104 | 43 | -39 | -72 |
| 16 | -29 | -4 | 74 | 129 | 153 | 169 | 190 | 188 | 149 | 103 | 46 | -40 | -71 |
| 17 | -32 | -1 | 87 | 130 | 160 | 175 | 188 | 187 | 147 | 106 | 44 | -36 | -68 |
| 18 | -33 | -2 | 78 | 127 | 160 | 178 | 194 | 187 | 152 | 108 | 46 | -31 | -63 |
| 19 | -34 | -3 | 68 | 116 | 145 | 175 | 200 | 190 | 155 | 116 | 52 | -27 | -57 |
| 20 | -30 | -1 | 65 | 122 | 153 | 179 | 205 | 199 | 161 | 111 | 59 | -17 | -49 |
| 21 | -25 | 0 | 67 | 126 | 161 | 179 | 207 | 202 | 171 | 121 | 69 | -7 | -40 |
| 22 | -19 | 1 | 72 | 130 | 162 | 186 | 208 | 203 | 174 | 124 | 67 | -2 | -32 |
| 23 | -21 | -1 | 66 | 122 | 155 | 180 | 207 | 201 | 168 | 123 | 67 | 0 | -25 |
| 24 | -23 | -2 | 61 | 117 | 155 | 183 | 208 | 201 | 165 | 121 | 65 | 3 | -19 |
| 25 | -25 | -3 | 61 | 118 | 157 | 190 | 209 | 201 | 165 | 117 | 63 | 3 | -17 |
| 26 | -26 | -5 | 55 | 113 | 151 | 188 | 207 | 198 | 164 | 112 | 60 | 4 | -16 |
| 27 | -28 | -9 | 51 | 110 | 149 | 186 | 199 | 193 | 164 | 110 | 60 | 6 | -14 |
| 28 | -31 | -9 | 44 | 99 | 150 | 189 | 201 | 195 | 165 | 111 | 61 | 9 | -13 |
| 29 | -31 | -6 | 44 | 97 | 144 | 186 | 203 | 198 | 170 | 115 | 66 | 13 | -6 |
| 30 | -28 | -4 | 46 | 98 | 137 | 181 | 200 | 198 | 173 | 124 | 72 | 21 | -2 |
| 31 | -22 | 0 | 46 | 92 | 130 | 172 | 192 | 195 | 178 | 128 | 80 | 28 | 6 |
| 32 | -15 | 4 | 46 | 87 | 117 | 153 | 176 | 186 | 174 | 126 | 64 | 32 | 13 |
| 33 | -8 | 6 | 39 | 69 | 89 | 116 | 152 | 161 | 158 | 117 | 72 | 31 | 17 |
| 34 | -2 | 8 | 27 | 40 | 56 | 70 | 92 | 102 | 96 | 80 | 49 | 27 | 21 |
| 35 | 0 | 7 | 15 | 18 | 23 | 26 | 24 | 29 | 33 | 26 | 24 | 21 | 22 |
| 36 | 0 | 6 | 1 | -2 | 9 | 4 | 5 | 7 | 12 | 9 | 14 | 17 | 19 |

## TABLE II

### Location of Strain Gages

| Plate (nominal deflection) | | 0 | 1/8" | 3/16" | 1/4" |
|---|---|---|---|---|---|
| Gage Number | | Distance from left edge (in) | | | |
| 1 | | 12.4 | 0.4 | 0.4 | 0.4 |
| 2 | | 1.4 | 1.4 | 1.4 | 1.4 |
| 3 | | 2.3 | 2.3 | 2.3 | 2.3 |
| 4 | 18 | 3.75 | 3.75 | 3.75 | 3.75 |
| 5 | 19 | 5.1 | 5.1 | 5.1 | 5.1 |
| 6 | 20 | 6.5 | 6.4 | 6.4 | 6.4 |
| 7 | 21 | 8.0 | 8.0 | 8.0 | 8.0 |
| 8 | 22 | 10.0 | 10.0 | 10.0 | 10.0 |
| 9 | 23 | 12.0 | 12.0 | 12.0 | 11.5 |
| 10 | 24 | 14.0 | 14.0 | 14.0 | 14.0 |
| 11 | 25 | 16.0 | 16.0 | 16.0 | 16.0 |
| 12 | 26 | 17.0 | 17.35 | 17.6 | 17.6 |
| 13 | 27 | 18.75 | 18.75 | 18.9 | 18.9 |
| 14 | 28 | 20.2 | 20.1 | 20.15 | 20.15 |
| 15 | | 21.6 | 21.6 | 21.6 | 21.6 |
| 16 | | 22.7 | 22.5 | 22.5 | 22.5 |
| 17 | | 23.5 | 23.5 | 23.5 | 23.5 |
| | | Distance from outer edge | | | |
| A | D | 0.5 | 0.5 | 0.5 | 0.5 |
| B | C | 1.7 | 1.7 | 1.7 | 1.7 |
| E | H | 0.5 | 0.5 | 0.5 | 0.5 |
| F | G | 1.7 | 1.7 | 1.7 | 1.7 |

# TABLE III
## DATA SHEET
## STRAIN LOAD READINGS
## PLATE OF ZERO NOMINAL DEFLECTION
## FRONT FACE

LOAD IN POUNDS

| GAGE NUMBER | 0 | 15000 | 30000 | 45000 | 60000 | 75000 | 90000 | 105000 |
|---|---|---|---|---|---|---|---|---|
| 1 | 10-1915 | 12-195 | 12-425 | 12-625 | 12-850 | 12-1050 | 12-1260 | 12-1410 |
| 2* | 8-1045 | 8-1260 | 8-1500 | 8-1675 | 8-1880 | 10-65 | 10-240 | 10-335 |
| 3 | 14-0030 | 14-240 | 14-425 | 14-580 | 14-760 | 14-930 | 14-1090 | 14-1230 |
| 4* | 8-1225 | 8-1400 | 8-1570 | 8-1715 | 8-1880 | 10-30 | 10-180 | 10-335 |
| 5 | 14-0010 | 14-175 | 14-320 | 14-460 | 14-630 | 14-775 | 14-925 | 14-1050 |
| 6 | 8-1170 | 8-1320 | 8-1475 | 8-1615 | 8-1780 | 8-1930 | 10-90 | 10-240 |
| 7 | 8-1465 | 8-1600 | 8-1755 | 8-1900 | 10-70 | 10-220 | 10-370 | 10-480 |
| 8 | 10-175 | 10-310 | 10-460 | 10-620 | 10-800 | 10-965 | 10-1125 | 10-1200 |
| 9 | 14-1075 | 14-1200 | 14-1350 | 14-1510 | 14-1700 | 14-1870 | 16-40 | 16-180 |
| 10 | 14-920 | 14-1030 | 14-1170 | 14-1320 | 14-1500 | 14-1660 | 14-1820 | 14-1990 |
| 11 | 14-1170 | 14-1285 | 14-1420 | 14-1545 | 14-1710 | 14-1870 | 16-15 | 16-180 |
| 12 | 12-1820 | 12-1925 | 14-45 | 14-160 | 14-310 | 14-440 | 14-580 | 14-810 |
| 13 | 14-50 | 14-165 | 14-290 | 14-400 | 14-530 | 14-660 | 14-790 | 14-935 |
| 14 | 12-1480 | 12-1620 | 12-1760 | 12-1885 | 14-20 | 14-160 | 14-300 | 14-430 |
| 15 | 14-445 | 14-605 | 14-765 | 14-905 | 14-1070 | 14-1220 | 14-1370 | 14-1530 |
| 16 | 12-1480 | 12-1670 | 12-1860 | 14-30 | 14-225 | 14-400 | 14-580 | 14-750 |
| 17 | 12-1090 | 12-1310 | 12-1530 | 12-1710 | 12-1935 | 14-130 | 14-330 | 14-530 |
| 18 | 10-610 | 10-780 | 10-950 | 10-1080 | 10-1245 | 10-1400 | 10-1550 | 12-80 |
| 19 | 10-265 | 10-435 | 10-590 | 10-730 | 10-900 | 10-1040 | 10-1190 | 10-1430 |
| 20 | 8-1160 | 8-1315 | 8-1460 | 8-1600 | 8-1760 | 8-1910 | 10-65 | 10-215 |
| 21 | 10-225 | 10-380 | 10-530 | 10-675 | 10-850 | 10-1015 | 10-1180 | 10-1345 |
| 22 | 10-435 | 10-540 | 10-665 | 10-790 | 10-940 | 10-1080 | 10-1230 | 10-1355 |
| 23 | 8-1910 | 10-20 | 10-130 | 10-255 | 10-405 | 10-540 | 10-690 | 10-820 |
| 24 | 10-10 | 10-115 | 10-230 | 10-350 | 10-500 | 10-640 | 10-790 | 10-940 |
| 25 | 10-1155 | 10-1260 | 10-1380 | 10-1480 | 10-1630 | 10-1760 | 10-1910 | 12-110 |
| 26 | 8-1330 | 8-1440 | 8-1575 | 8-1700 | 8-1850 | 10-005 | 10-150 | 10-265 |
| 27 | 8-1185 | 8-1320 | 8-1460 | 8-1590 | 8-1755 | 8-1900 | 10-55 | 10-1170 |
| 28 | 10-670 | 10-820 | 10-965 | 10-1090 | 10-1240 | 10-1390 | 10-1540 | 12-260 |

Strain readings in micro inch per inch

## TABLE III (continued)

## DATA SHEET

## Strain-Load Readings

## Plate of Zero Nominal Deflection

## Back Face

LOAD IN POUNDS

| GAGE NUMBER | 0 | 15000 | 30000 | 45000 | 60000 | 75000 | 90000 | 105000 |
|---|---|---|---|---|---|---|---|---|
| 1 | 8-870 | 8-950 | 8-1035 | 8-1090 | 8-1180 | 8-1230 | 8-1360 | 8-1370 |
| 2 | 10-1265 | 10-1385 | 10-1505 | 10-1590 | 10-1710 | 10-1815 | 10-1930 | 10-1970 |
| 3 | 10-1630 | 10-1800 | 10-1945 | 12-70 | 12-220 | 12-350 | 12-485 | 12-620 |
| A | 10-1870 | 10-1980 | 12-90 | 12-165 | 12-260 | 12-335 | 12-420 | 12-580 |
| B | 10-450 | 10-430 | 10-415 | 10-390 | 10-380 | 10-355 | 10-325 | 10-280 |
| C | 12-000 | 10-1980 | 10-1965 | 10-1935 | 10-1920 | 10-1895 | 10-1855 | 10-1815 |
| D | 10-1800 | 10-1905 | 12-0000 | 12-75 | 12-170 | 12-245 | 12-330 | 12-490 |
| 4 | 12-340 | 12-510 | 12-680 | 12-825 | 12-985 | 12-1130 | 12-1285 | 12-1415 |
| 5 | 10-1130 | 10-1310 | 10-1480 | 10-1630 | 10-1845 | 10-1950 | 12-105 | 12-230 |
| 6 | 10-1800 | 10-1980 | 12-170 | 12-340 | 12-530 | 12-705 | 12-875 | 12-1090 |
| 7 | 10-835 | 10-975 | 10-1130 | 10-1280 | 10-1445 | 10-1600 | 10-1760 | 10-1930 |
| 8 | 12-420 | 12-525 | 12-670 | 12-810 | 12-970 | 12-1120 | 12-1270 | 12-1445 |
| 9 | 8-1410 | 8-1525 | 8-1650 | 8-1790 | 8-1940 | 10-100 | 10-245 | 10-380 |
| 10 | 10-1650 | 10-1760 | 10-1890 | 12-30 | 12-195 | 12-345 | 12-490 | 12-670 |
| 11 | 10-1770 | 10-1900 | 12-40 | 12-185 | 12-340 | 12-500 | 12-655 | 12-825 |
| 12 | 10-1710 | 10-1850 | 12-15 | 12-170 | 12-340 | 12-500 | 12-665 | 12-930 |
| 13 | 10-1765 | 10-1930 | 12-90 | 12-250 | 12-415 | 12-570 | 12-735 | 12-890 |
| 14 | 12-180 | 12-330 | 12-470 | 12-610 | 12-745 | 12-880 | 12-1020 | 12-1145 |
| E | 10-540 | 10-630 | 10-690 | 10-750 | 10-820 | 10-880 | 10-940 | 10-1030 |
| F | 10-1475 | 10-1475 | 10-1440 | 10-1415 | 10-1390 | 10-1360 | 10-1320 | 10-1280 |
| G | 10-1460 | 10-1470 | 10-1455 | 10-1420 | 10-1415 | 10-1400 | 10-1370 | 10-1335 |
| H | 12-100 | 12-200 | 12-280 | 12-340 | 12-425 | 12-490 | 12-565 | 12-650 |
| 15 | 10-1390 | 10-1530 | 10-1650 | 10-1765 | 10-1890 | 12-10 | 12-145 | 12-280 |
| 16 | 12-465 | 12-505 | 12-520 | 12-550 | 12-595 | 12-630 | 12-680 | 12-740 |
| 17 | 10-1315 | 10-1410 | 10-1490 | 10-1570 | 10-1655 | 10-1750 | 10-1845 | 10-1940 |
| 18 | 12-010 | 12-200 | 12-360 | 12-515 | 12-670 | 12-820 | 12-980 | 12-1640 |
| 19 | 10-1305 | 10-1490 | 10-1660 | 10-1800 | 10-1965 | 12-115 | 12-270 | 12-560 |
| 20 | 10-1460 | 10-1630 | 10-1790 | 10-1950 | 12-110 | 12-260 | 12-415 | 12-545 |
| 21 | 12-370 | 12-520 | 12-660 | 12-810 | 12-970 | 12-1110 | 12-1260 | 12-1375 |
| 22 | 10-1730 | 10-1890 | 12-55 | 12-225 | 12-410 | 12-575 | 12-750 | 12-880 |
| 23 | 10-1140 | 10-1285 | 10-1430 | 10-1590 | 10-1770 | 10-1935 | 12-110 | 12-240 |
| 24 | 10-1400 | 10-1550 | 10-1690 | 10-1850 | 12-30 | 12-190 | 12-370 | 12-545 |
| 25 | 10-530 | 10-670 | 10-815 | 10-965 | 10-1125 | 10-1300 | 10-1465 | 10-1735 |
| 26 | 10-1980 | 12-120 | 12-250 | 12-390 | 12-535 | 12-690 | 12-840 | 12-1010 |
| 27 | 10-1710 | 10-1835 | 10-1950 | 12-90 | 12-220 | 12-355 | 12-495 | 12-1395 |
| 28 | 12-270 | 12-405 | 12-520 | 12-650 | 12-785 | 12-915 | 12-1050 | 12-1785 |

Strain readings in micro-inch per inch

# TABLE III(continued)
## DATA SHEET
### Strain -Load Readings
### Plate of 1/8" Nominal Deflection
### Front Face

LOAD IN POUNDS

| GAGE NUMBER | 0 | 20000 | 35000 | 50000 | 65000 | 80000 | 95000 |
|---|---|---|---|---|---|---|---|
| 1 | 12-1930 | 14-600 | 14-815 | 14-1000 | 14-1190 | 14-1350 | 14-1530 |
| 2 | 12-1870 | 14-525 | 14-750 | 14-940 | 14-1130 | 14-1290 | 14-1470 |
| 3 | 14-585 | 14-1175 | 14-1380 | 14-1565 | 14-1755 | 14-1930 | 16-100 |
| 4 | 12-980 | 12-1560 | 12-1765 | 12-1940 | 14-130 | 14-300 | 14-450 |
| 5 | 14-1230 | 14-1865 | 16-90 | 16-295 | 16-450 | 16-700 | 16-865 |
| 6 | 14-105 | 14-790 | 14-1050 | 14-1280 | 14-1530 | 14-1770 | 14-1980 |
| 7 | 14-830 | 14-1525 | 14-1800 | 16-50 | 16-310 | 16-545 | 16-760 |
| 8 | 12-640 | 12-1310 | 12-1570 | 12-1810 | 14-70 | 14-300 | 14-510 |
| 9 | 14-590 | 14-1190 | 14-1450 | 14-1680 | 14-1940 | 16-180 | 16-400 |
| 10 | 12-810 | 12-1415 | 12-1690 | 12-1940 | 14-210 | 14-455 | 14-685 |
| 11 | 14-630 | 14-1240 | 14-1510 | 14-1750 | 16-10 | 16-240 | 16-510 |
| 12 | 14-415 | 14-995 | 14-1260 | 14-1485 | 14-1730 | 14-1940 | 16-175 |
| 13 | 12-720 | 12-1215 | 12-1415 | 12-1595 | 12-1790 | 12-1965 | 14-140 |
| 14 | 12-1930 | 14-420 | 14-615 | 14-780 | 14-955 | 14-1120 | 14-1275 |
| 15 | 12-1740 | 14-210 | 14-415 | 14-580 | 14-765 | 14-920 | 14-1080 |
| 16 | 12-80 | 12-570 | 12-780 | 12-960 | 12-1150 | 12-1310 | 12-1490 |
| 17 | 12-540 | 12-990 | 12-1220 | 12-1390 | 12-1580 | 12-1750 | 12-1945 |
| 18 | 12-1610 | 14-80 | 14-300 | 14-485 | 14-680 | 14-850 | 14-1015 |
| 19 | 12-665 | 12-1060 | 12-1255 | 12-1415 | 12-1600 | 12-1770 | 12-1945 |
| 20 | 12-1060 | 12-1420 | 12-1605 | 12-1790 | 12-1980 | 14-170 | 14-370 |
| 21 | 12-760 | 12-1115 | 12-1300 | 12-1475 | 12-1660 | 12-1850 | 14-70 |
| 22 | 12-1875 | 14-260 | 14-445 | 14-620 | 14-810 | 14-1000 | 14-1210 |
| 23 | 12-510 | 12-980 | 12-1150 | 12-1345 | 12-1550 | 12-1760 | 14-10 |
| 24 | 12-1840 | 14-280 | 14-480 | 14-680 | 14-890 | 14-1100 | 14-1355 |
| 25 | 14-1350 | 14-1755 | 14-1925 | 16-100 | 16-290 | 16-475 | 16-670 |
| 26 | 12-1900 | 14-340 | 14-505 | 14-670 | 14-850 | 14-1030 | 14-1210 |
| 27 | 14-1040 | 14-1470 | 14-1675 | 14-1865 | 16-60 | 16-240 | 16-440 |
| 28 | 12-1080 | 12-1510 | 12-1715 | 12-1890 | 14-80 | 14-250 | 14-430 |

Strain readings in micro-inch per inch

TABLE III (continued)

## DATA SHEET

Strain-Load Readings
Plate of 1/8"Nominal Deflection
Back Face

LOAD IN POUNDS

| GAGE NUMBER | 0 | 2000 | 35000 | 50000 | 65000 | 80000 | 95000 |
|---|---|---|---|---|---|---|---|
| 1 | 14-900 | 14-1210 | 14-1375 | 14-1525 | 14-1680 | 14-1820 | 14-1975 |
| 2 | 14-530 | 14-875 | 14-1060 | 14-1220 | 14-1380 | 14-1535 | 14-1700 |
| 3 | 14-610 | 14-975 | 14-1170 | 14-1340 | 14-1510 | 14-1665 | 14-1840 |
| A | 14-1800 | 16-60 | 16-165 | 16-265 | 16-360 | 16-440 | 16-515 |
| B | 14-720 | 14-830 | 14-815 | 14-800 | 14-790 | 14-760 | 14-710 |
| C | 16-20 | 16-170 | 16-170 | 16-165 | 16-170 | 16-160 | 16-120 |
| D | 14-980 | 14-1240 | 14-1350 | 14-1450 | 14-1550 | 14-1650 | 14-1730 |
| 4 | 14-1310 | 14-1660 | 14-1850 | 16-25 | 16-205 | 16-370 | 16-540 |
| 5 | 14-970 | 14-1190 | 14-1280 | 14-1370 | 14-1490 | 14-1590 | 14-1690 |
| 6 | 16-360 | 16-510 | 16-560 | 16-610 | 16-690 | 16-780 | 16-870 |
| 7 | 14-1680 | 14-1805 | 14-1850 | 14-1910 | 16-0 | 16-105 | 16-210 |
| 8 | 16-1110 | 16-1220 | 16-1260 | 16-1320 | 16-1405 | 16-1510 | 16-1630 |
| 9 | 16-500 | 16-580 | 16-590 | 16-610 | 16-680 | 16-760 | 16-860 |
| 10 | 14-1045 | 14-1110 | 14-1115 | 14-1140 | 14-1200 | 14-1275 | 14-1350 |
| 11 | 14-1920 | 16-50 | 16-80 | 16-135 | 16-215 | 16-300 | 16-410 |
| 12 | 14-620 | 14-780 | 14-830 | 14-890 | 14-980 | 14-1070 | 14-1170 |
| 13 | 14-1810 | 16-50 | 16-155 | 16-255 | 16-370 | 16-480 | 16-590 |
| 14 | 16-135 | 16-490 | 16-670 | 16-820 | 16-980 | 16-1125 | 16-1270 |
| E | 14-1900 | 16-170 | 16-280 | 16-370 | 16-475 | 16-560 | 16-630 |
| F | 14-1730 | 14-1850 | 14-1870 | 14-1875 | 14-1885 | 14-1890 | 14-1850 |
| G | 14-1530 | 14-1635 | 14-1640 | 14-1640 | 14-1640 | 14-1630 | 14-1510 |
| H | 14-505 | 14-755 | 14-855 | 14-950 | 14-1041 | 14-1120 | 14-1190 |
| 15 | 14-890 | 14-1230 | 14-1410 | 14-1575 | 14-1740 | 14-1890 | 16-50 |
| 16 | 14-1190 | 14-1530 | 14-1705 | 14-1850 | 16-10 | 16-150 | 16-300 |
| 17 | 14-1870 | 16-175 | 16-320 | 16-450 | 16-585 | 16-700 | 16-840 |
| 18 | 14-1480 | 14-1800 | 14-1965 | 16-115 | 16-265 | 16-400 | 16-550 |
| 19 | 12-1690 | 12-1890 | 12-1970 | 14-60 | 14-140 | 14-225 | 14-285 |
| 20 | 14-1390 | 14-1610 | 14-1705 | 14-1790 | 14-1880 | 14-1970 | 16-35 |
| 21 | -- | -- | -- | -- | -- | -- | -- |
| 22 | 14-785 | 14-1030 | 14-1130 | 14-1235 | 14-1355 | 14-1470 | 14-1585 |
| 23 | 14-1130 | 14-1315 | 14-1395 | 14-1470 | 14-1560 | 14-1650 | 14-1730 |
| 24 | 16-145 | 16-315 | 16-410 | 16-480 | 16-560 | 16-645 | 16-715 |
| 25 | 14-1590 | 14-1840 | 14-1980 | 16-100 | 16-230 | 16-360 | 16-475 |
| 26 | 14-1140 | 14-1380 | 14-1490 | 14-1585 | 14-1685 | 14-1785 | 14-1875 |
| 27 | 14-1950 | 16-175 | 16-280 | 16-365 | 16-455 | 16-540 | 16-630 |
| 28 | 14-110 | 14-1400 | 14-1590 | 14-1745 | 14-1900 | 16-40 | 16-200 |

TABLE III (continued)

DATA SHEET

Strain-Load Readings

Plate of 3/16" Nominal Deflection

Front Face

LOAD IN POUNDS

| GAGE NUMBER | 0 | 15000 | 30000 | 45000 | 60000 | 75000 | 90000 | 105000 |
|---|---|---|---|---|---|---|---|---|
| 1 | 8-1430 | 8-1820 | 8-1950 | 10-170 | 10-350 | 10-500 | 10-645 | 10-880 |
| 2 | 8-170 | 8-580 | 8-715 | 8-960 | 8-1150 | 8-1300 | 8-1465 | 8-1500 |
| 3 | 8-570 | 8-1000 | 8-1155 | 8-1400 | 8-1600 | 8-1775 | 8-1955 | 8-1975 |
| 4 | 6-1185 | 6-1640 | 6-1815 | 8-80 | 8-300 | 8-485 | 8-560 | 8-1945 |
| 5 | 6-1685 | 8-175 | 8-380 | 8-670 | 8-915 | 8-1125 | 8-1370 | 8-1420 |
| 6 | 8-335 | 8-900 | 8-1200 | 8-1570 | 8-1890 | 10-180 | 10-470 | 10-335 |
| 7 | 8-540 | 8-1140 | 8-1460 | 8-1850 | 10-200 | 10-510 | 10-755 | 10-720 |
| 8 | 8-260 | 8-840 | 8-1130 | 8-1490 | 8-1795 | 10-85 | 10-290 | 10-220 |
| 9 | 8-140 | 8-730 | 8-1025 | 8-1370 | 8-1670 | 8-1950 | 10-110 | 10-70 |
| 10 | 6-1980 | 8-645 | 8-990 | 8-1385 | 8-1720 | 10-50 | 10-205 | 10-650 |
| 11 | 6-860 | 6-1485 | 6-1820 | 8-185 | 8-505 | 8-800 | 8-1025 | 8-840 |
| 12 | 8-120 | 8-745 | 8-1050 | 8-1405 | 8-1700 | 8-1995 | 10-270 | 10-70 |
| 13 | 8-265 | 8-835 | 8-1095 | 8-1400 | 8-1655 | 8-1900 | 10-150 | 10-550 |
| 14 | 6-1200 | 6-1690 | 6-1895 | 8-145 | 8-370 | 8-560 | 8-770 | 10-310 |
| 15 | 8-720 | 8-1175 | 8-1355 | 8-1570 | 8-1760 | 8-1940 | 10-115 | 10-900 |
| 16 | 8-970 | 8-1425 | 8-1600 | 8-1810 | 8-1990 | 10-150 | 10-340 | 10-660 |
| 17 | 8-100 | 8-520 | 8-690 | 8-880 | 8-1050 | 8-1190 | 8-1415 | 8-1530 |
| 18 | 8-190 | 8-600 | 8-805 | 8-1055 | 8-1260 | 8-1470 | 8-1700 | 10-1100 |
| 19 | 6-1520 | 6-1880 | 8-20 | 8-215 | 8-370 | 8-540 | 8-760 | 10-1380 |
| 20 | 8-1600 | 8-1870 | 8-1905 | 10-000 | 10-100 | 10-200 | 10-320 | 10-470 |
| 21 | 6-1690 | 6-1955 | 6-1980 | 8-70 | 8-160 | 8-260 | 8-380 | 8-565 |
| 22 | 8-1035 | 8-1330 | 8-1380 | 8-1510 | 8-1625 | 8-1770 | 8-960 | 10-380 |
| 23 | 8-540 | 8-810 | 8-885 | 8-1000 | 8-1110 | 8-1250 | 8-1415 | 8-1960 |
| 24 | 8-1050 | 8-1335 | 8-1390 | 8-1515 | 8-1640 | 8-1780 | 8-1930 | 10-420 |
| 25 | 8-1240 | 8-1490 | 8-1510 | 8-1585 | 8-1675 | 8-1760 | 8-1930 | 10-220 |
| 26 | 8-1180 | 8-1510 | 8-1590 | 8-1735 | 8-1860 | 8-1980 | 10-260 | 10-310 |
| 27 | 8-1100 | 8-1535 | 8-1730 | 8-1950 | 10-140 | 10-330 | 10-570 | 10-1385 |
| 28 | 8-920 | 8-1365 | 8-1565 | 8-1795 | 8-1980 | 10-165 | 10-330 | 10-500 |

Strain readings in micro-inch per inch.

TABLE III (continued)

DATA SHEET

Strain-Load Readings

Plate of 3/16" Nominal Deflection

Back Face

LOAD IN POUNDS

| GAGE NUMBER | 0 | 15000 | 30000 | 45000 | 60000 | 75000 | 90000 | 105000 |
|---|---|---|---|---|---|---|---|---|
| 1 | 8-480 | 8-855 | 8-1040 | 8-1265 | 8-1450 | 8-1630 | 8-1800 | 10-30 |
| 2 | 10-1425 | 10-1810 | 10-1985 | 12-225 | 12-410 | 12-600 | 12-770 | 12-800 |
| 3 | 8-1545 | 8-1915 | 10-100 | 10-310 | 10-495 | 10-670 | 10-855 | 10-920 |
| A | 12-445 | 12-730 | 12-820 | 12-930 | 12-1020 | 12-1110 | 12-1120 | 12-1660 |
| B | 12-085 | 12-270 | 12-225 | 12-200 | 12-160 | 12-140 | 12-70 | 10-1900 |
| C | 10-1370 | 10-1585 | 10-1570 | 10-1570 | 10-1570 | 10-1550 | 10-1525 | 10-1430 |
| D | 10-1735 | 12-45 | 12-140 | 12-290 | 12-400 | 12-505 | 12-625 | 12-1115 |
| 4 | 10-1910 | 12-280 | 12-450 | 12-650 | 12-825 | 12-995 | 12-1190 | 12-425 |
| 5 | 8-720 | 8-950 | 8-985 | 8-1025 | 8-1090 | 8-1140 | 8-1240 | 8-1760 |
| 6 | 8-860 | 8-1010 | 8-975 | 8-945 | 8-950 | 8-970 | 8-995 | 8-1550 |
| 7 | 8-1240 | 8-1320 | 8-1230 | 8-1160 | 8-1120 | 8-1090 | 8-1140 | 8-1685 |
| 8 | 8-380 | 8-450 | 8-350 | 8-290 | 8-255 | 8-270 | 8-300 | 8-650 |
| 9 | 6-1750 | 6-1820 | 6-1760 | 6-1710 | 6-1680 | 6-1705 | 6-1760 | 8-130 |
| 10 | 8-1080 | 8-1200 | 8-1130 | 8-1100 | 8-1080 | 8-1110 | 8-1220 | 8-1900 |
| 11 | 8-560 | 8-670 | 8-590 | 8-535 | 8-520 | 8-540 | 8-590 | 8-1210 |
| 12 | 8-490 | 8-620 | 8-600 | 8-595 | 8-600 | 8-640 | 8-710 | 8-1365 |
| 13 | 8-100 | 8-350 | 8-420 | 8-495 | 8-570 | 8-660 | 8-755 | 8-1520 |
| 14 | 8-750 | 8-1140 | 8-1330 | 8-1510 | 8-1660 | 8-1830 | 10-240 | 10-1230 |
| E | 10-1935 | 12-270 | 12-400 | 12-525 | 12-615 | 12-700 | 12-850 | 12-1365 |
| F | 10-875 | 10-1075 | 10-1070 | 10-1080 | 10-1075 | 10-1040 | 10-1015 | 10-945 |
| G | 12-175 | 12-345 | 12-300 | 12-260 | 12-230 | 12-175 | 12-105 | 10-1965 |
| H | 12-115 | 12-430 | 12-530 | 12-615 | 12-695 | 12-780 | 12-875 | 12-1370 |
| 15 | 8-1440 | 8-1865 | 10-70 | 10-260 | 10-425 | 10-590 | 10-790 | 10-1490 |
| 16 | 6-1505 | 6-1920 | 8-120 | 8-310 | 8-470 | 8-635 | 8-810 | 8-1115 |
| 17 | 8-985 | 8-1400 | 8-1635 | 8-1815 | 8-1955 | 10-120 | 10-300 | 10-500 |
| 18 | 12-175 | 12-520 | 12-700 | 12-860 | 12-1010 | 12-1190 | 12-1325 | 14-740 |
| 19 | 10-1250 | 10-1515 | 10-1590 | 10-1670 | 10-1750 | 10-1820 | 10-1870 | 10-1580 |
| 20 | 12-085 | 12-410 | 12-540 | 12-690 | 12-830 | 12-955 | 12-1060 | 12-1345 |
| 21 | 12-800 | 12-1175 | 12-1350 | 12-1540 | 12-1730 | 12-1900 | 14-25 | 14-255 |
| 22 | 12-275 | 12-600 | 12-715 | 12-850 | 12-990 | 12-1115 | 12-1150 | 12-1390 |
| 23 | 10-960 | 10-1295 | 10-1395 | 10-1550 | 10-1685 | 10-1800 | 10-1845 | 10-1965 |
| 24 | 12-650 | 12-1025 | 12-1200 | 12-1375 | 12-1560 | 12-1720 | 12-1825 | 14-215 |
| 25 | 12-000 | 12-420 | 12-620 | 12-840 | 12-1050 | 12-1250 | 12-1350 | 12-1650 |
| 26 | 10-1425 | 10-1785 | 10-1955 | 12-130 | 12-310 | 12-435 | 12-460 | 12-655 |
| 27 | 12-310 | 12-640 | 12-760 | 12-885 | 12-1020 | 12-1105 | 12-1125 | 12-1030 |
| 28 | 8-375 | 8-740 | 8-900 | 8-1060 | 8-1205 | 8-1325 | 8-1430 | 8-1545 |

Strain readings in micro-inch per inch.

## TABLE III (continued)
## DATA SHEET
## Strain-Load Readings
## Plate of 1/4" Nominal Deflection
## Front Face

LOAD IN POUNDS

| GAGE NUMBER | 0# | $10^{K\#}$ | $20^{K\#}$ | $30^{K\#}$ | $40^{K\#}$ | $50^{K\#}$ |
|---|---|---|---|---|---|---|
| 1 | 14-445 | 14-560 | 14-670 | 14-760 | 14-860 | 14-955 |
| 2 | 14-1080 | 14-1210 | 14-1330 | 14-1450 | 14-1565 | 14-1680 |
| 3 | 16-370 | 16-510 | 16-640 | 16-760 | 16-880 | 16-1000 |
| 4 | 16-290 | 16-450 | 16-605 | 16-750 | 16-890 | 16-1025 |
| 5 | 16-160 | 16-380 | 16-590 | 16-790 | 16-980 | 16-1165 |
| 6 | 14-1795 | 16-95 | 16-395 | 16-640 | 16-890 | 16-1125 |
| 7 | 14-660 | 14-950 | 14-1230 | 14-1480 | 14-1720 | 14-1950 |
| 8 | 14-1290 | 14-1555 | 14-1815 | 16-55 | 16-280 | 16-510 |
| 9 | 14-1620 | 14-1915 | 16-210 | 16-470 | 16-720 | 16-970 |
| 10 | 14-1050 | 14-1330 | 14-1610 | 14-1875 | 16-120 | 16-365 |
| 11 | 14-1525 | 14-1810 | 16-100 | 16-370 | 16-620 | 16-875 |
| 12 | 14-590 | 14-850 | 14-1110 | 14-1360 | 14-1590 | 14-1820 |
| 13 | 14-1075 | 14-1285 | 14-1500 | 14-1710 | 14-1895 | 16-90 |
| 14 | 14-1975 | 16-140 | 16-310 | 16-475 | 16-625 | 16-770 |
| 15 | 16-0 | 16-140 | 16-280 | 16-415 | 16-540 | 16-665 |
| 16 | 14-1890 | 16-10 | 16-130 | 16-255 | 16-370 | 16-485 |
| 17 | 14-890 | 14-990 | 14-1100 | 14-1210 | 14-1310 | 14-1410 |
| 18 | 16-60 | 16-215 | 16-360 | 16-500 | 16-620 | 16-745 |
| 19 | 16-430 | 16-560 | 16-690 | 16-820 | 16-930 | 16-1045 |
| 20 | 14-1280 | 14-1360 | 14-1435 | 14-1510 | 14-1585 | 14-1660 |
| 21 | 14-270 | 14-305 | 14-340 | 14-380 | 14-425 | 14-470 |
| 22 | 14-1775 | 14-1810 | 14-1850 | 14-1900 | 14-1940 | 14-2000 |
| 23 | 14-1475 | 14-1500 | 14-1520 | 14-1560 | 14-1595 | 14-1640 |
| 24 | 14-785 | 14-795 | 14-805 | 14-820 | 14-840 | 14-870 |
| 25 | 14-1520 | 14-1505 | 14-1495 | 14-1490 | 14-1490 | 14-1500 |
| 26 | 14-1205 | 14-1260 | 14-1310 | 14-1365 | 14-1415 | 14-1465 |
| 27 | 14-1415 | 14-1530 | 14-1640 | 14-1750 | 14-1850 | 14-1940 |
| 28 | 14-1475 | 14-1605 | 14-1740 | 14-1870 | 14-1985 | 16-95 |

Strain readings in micro inch per inch

# TABLE III (continued)

## DATA SHEET

Strain-Load Readings
Plate of 1/4" Nominal Deflection
Front Face (continued)

LOAD IN POUNDS

| GAGE NUMBER | 60 K# | 70 K# | 80 K# | 90 K# | 100 K# | 110 K# |
|---|---|---|---|---|---|---|
| 1 | 14-1050 | 14-1140 | 14-1230 | 14-1325 | 14-1455 | 14-1645 |
| 2 | 14-1785 | 14-1890 | 14-1990 | 16-100 | 16-155 | 16-110 |
| 3 | 16-1110 | 16-1220 | 16-1325 | 16-1430 | 16-1500 | 18-280 |
| 4 | 16-1155 | 16-1280 | 16-1405 | 16-1520 | 18-30 | 18-1130 |
| 5 | 16-1345 | 16-1510 | 16-1680 | 16-1840 | 16-1990 | 18-345 |
| 6 | 16-1360 | 16-1575 | 16-1780 | 16-1990 | 18-440 | 18-1260 |
| 7 | 16-190 | 16-400 | 16-610 | 16-825 | k6-1215 | 16-1240 |
| 8 | 16-730 | 16-940 | 16-1150 | 16-1375 | 16-1485 | 16-1365 |
| 9 | 16-1215 | 16-1440 | 16-1665 | 16-1915 | 18-45 | 18-20 |
| 10 | 16-610 | 16-830 | 16-1060 | 16-1340 | 16-1445 | 16-1535 |
| 11 | 16-1130 | 16-1360 | 16-1610 | 16-1930 | 16-1920 | 16-1770 |
| 12 | 16-55 | 16-270 | 16-490 | 16-760 | 16-760 | 16-920 |
| 13 | 16-280 | 16-450 | 16-630 | 16-820 | 16-1775 | 18-1510 |
| 14 | 16-920 | 16-1055 | 16-1190 | 16-1340 | 18-560 | 20-30 |
| 15 | 16-790 | 16-910 | 16-1025 | 16-1150 | 16-1200 | 16-1300 |
| 16 | 16-600 | 16-705 | 16-815 | 16-925 | 16-880 | 16-845 |
| 17 | 14-1510 | 14-1615 | 14-1710 | 14-1810 | 14-1770 | 14-1755 |
| 18 | 16-870 | 16-990 | 16-1105 | 16-1220 | 16-1485 | 18-800 |
| 19 | 16-1160 | 16-1270 | 16-1380 | 16-1495 | 16-1880 | 18-1000 |
| 20 | 14-1730 | 14-1820 | 14-1905 | 16-0 | 16-345 | 16-1535 |
| 21 | 14-525 | 14-590 | 14-660 | 14-730 | 14-905 | 14-920 |
| 22 | 16-65 | 16-140 | 16-225 | 16-310 | 16-480 | 16-1075 |
| 23 | 14-1700 | 14-1760 | 14-1840 | 14-1920 | 16-125 | 16-345 |
| 24 | 14-910 | 14-960 | 14-1020 | 14-1090 | 14-1235 | 14-1360 |
| 25 | 14-1510 | 14-1540 | 14-1575 | 14-1610 | 14-1805 | 14-1935 |
| 26 | 14-1530 | 14-1590 | 14-1660 | 14-1740 | 14-1985 | 16-135 |
| 27 | 16-40 | 16-135 | 16-235 | 16-340 | 16-1290 | 18-710 |
| 28 | 16-210 | 16-315 | 16-430 | 16-550 | 16-1840 | 18-940 |

Strain readings in micro inch per inch

## TABLE III (continued)

### DATA SHEET

### Strain-Load Readings
### Plate of 1/4" Nominal Deflection
### Back Face

| GAGE NUMBER | LOAD IN POUNDS 0# | $10^{K\#}$ | $20^{K\#}$ | $30^{K\#}$ | $40^{K\#}$ | $50^{K\#}$ |
|---|---|---|---|---|---|---|
| 1B | 14-395 | 14-525 | 14-655 | 14-780 | 14-900 | 14-1010 |
| 2 | 14-1545 | 14-1670 | 14-1790 | 14-1910 | 16-25 | 16-135 |
| 3 | 12-1970 | 14-100 | 14-230 | 14-350 | 14-470 | 14-580 |
| A | 14-1680 | 14-1740 | 14-1800 | 14-1860 | 14-1915 | 14-1970 |
| B | 14-1835 | 14-1785 | 14-1740 | 14-1705 | 14-1665 | 14-1635 |
| C | 14-1025 | 14-1000 | 14-980 | 14-970 | 14-950 | 14-940 |
| D | 14-1545 | 14-1615 | 14-1690 | 14-1760 | 14-1825 | 14-1890 |
| 4 | 14-900 | 14-1025 | 14-1155 | 14-1275 | 14-1390 | 14-1505 |
| 5 | 14-1020 | 14-1020 | 14-1030 | 14-1045 | 14-1060 | 14-1085 |
| 6 | 14-115 | 14-10 | 12-1920 | 12-1855 | 12-1800 | 12-1765 |
| 7 | 14-660 | 14-550 | 14-450 | 14-360 | 14-300 | 14-255 |
| 8 | 12-570 | 12-420 | 12-280 | 12-160 | 12-50 | 10-1965 |
| 9 | 12-220 | 12-80 | 10-1960 | 10-1850 | 10-1760 | 10-1690 |
| 10 | 10-1880 | 10-1730 | 10-1590 | 10-1475 | 10-1370 | 10-1280 |
| 11 | 14-740 | 14-590 | 14-450 | 14-330 | 14-215 | 14-125 |
| 12 | 14-1725 | 14-1620 | 14-1515 | 14-1420 | 14-1340 | 14-1275 |
| 13 | 14-1080 | 14-1065 | 14-1050 | 14-1045 | 14-1040 | 14-1040 |
| 14 | 14-845 | 14-970 | 14-1100 | 14-1230 | 14-1350 | 14-1470 |
| E | 16-125 | 16-200 | 16-280 | 16-360 | 16-440 | 16-510 |
| F | 14-1440 | 14-1410 | 14-1390 | 14-1370 | 14-1345 | 14-1330 |
| G | 14-1795 | 14-1730 | 14-1670 | 14-1620 | 14-1565 | 14-1525 |
| H | 14-1085 | 14-1135 | 14-1195 | 14-1250 | 14-1305 | 14-1360 |
| 15 | 14-85 | 14-215 | 14-360 | 14-495 | 14-630 | 14-755 |
| 16 | 14-1550 | 14-1685 | 14-1835 | 14-1975 | 16-115 | 16-250 |
| 17 | 14-1985 | 16-120 | 16-275 | 16-415 | 16-550 | 16-685 |
| 18 | 14-1770 | 14-1885 | 16-0 | 16-110 | 16-215 | 16-320 |
| 19 | 14-1335 | 14-1390 | 14-1435 | 14-1485 | 14-1530 | 14-1580 |
| 20 | 14-1445 | 14-1530 | 14-1610 | 14-1690 | 14-1770 | 14-1850 |
| 21 | 14-1660 | 14-1770 | 14-1880 | 14-1990 | 16-100 | 16-210 |
| 22 | 14-1465 | 14-1545 | 14-1625 | 14-1710 | 14-1790 | 14-1870 |
| 23 | 14-1315 | 14-1410 | 14-1510 | 14-1605 | 14-1700 | 14-1800 |
| 24 | 14-810 | 14-930 | 14-1050 | 14-1170 | 14-1285 | 14-1405 |
| 25 | 14-1580 | 14-1680 | 14-1790 | 14-1900 | 16-10 | 16-120 |
| 26 | 16-20 | 16-80 | 16-150 | 16-220 | 16-290 | 16-360 |
| 27 | 14-1350 | 14-1410 | 14-1470 | 14-1530 | 14-1585 | 14-1640 |
| 28 | 14-950 | 14-1050 | 14-1155 | 14-1255 | 14-1355 | 14-1455 |

TABLE III (continued)

DATA SHEET

Strain-Load Readings

Plate of 1/4" Nominal Deflection

Back Face (continued)

LOAD IN POUNDS

| GAGE NUMBER | 60K# | 70K# | 80K# | 90K# | 100K# | 110K# |
|---|---|---|---|---|---|---|
| 1B | 14-1130 | 14-1235 | 14-1345 | 14-1450 | 14-1600 | 14-1800 |
| 2 | 16-245 | 16-345 | 16-450 | 16-550 | 16-540 | 16-580 |
| 3 | 14-690 | 14-790 | 14-900 | 14-1005 | 14-1055 | 14-1710 |
| A | 16-30 | 16-85 | 16-140 | 16-195 | 16-480 | 16-1160 |
| B | 14-1610 | 14-1580 | 14-1560 | 14-1530 | 14-1450 | 14-1320 |
| C | 14-930 | 14-920 | 14-915 | 4-900 | 14-840 | 14-730 |
| D | 14-1960 | 16-20 | 16-90 | 16-150 | 16-435 | 16-1095 |
| 4 | 14-1620 | 14-1720 | 14-1830 | 14-1940 | 16-460 | 16-1410 |
| 5 | 14-1115 | 14-1145 | 14-1180 | 14-1225 | 14-1330 | 14-1600 |
| 6 | 12-1740 | 12-1730 | 12-1730 | 12-1740 | 14-15 | 14-350 |
| 7 | 14-220 | 14-205 | 14-200 | 14-200 | 14-390 | 14-885 |
| 8 | 10-1890 | 10-1830 | 10-1790 | 10-1750 | 12-30 | 12-465 |
| 9 | 10-1625 | 10-1585 | 10-1550 | 10-1520 | 10-1725 | 12-55 |
| 10 | 10-1210 | 10-1145 | 10-1100 | 10-1040 | 10-1320 | 10-1770 |
| 11 | 14-40 | 12-1975 | 12-1920 | 12-1850 | 14-260 | 14-840 |
| 12 | 14-1220 | 14-1170 | 14-1130 | 14-1090 | 14-1525 | 16-90 |
| 13 | 14-1040 | 14-1050 | 14-1070 | 14-1080 | 14-1470 | 16-235 |
| 14 | 14-1590 | 14-1695 | 14-1810 | 14-1930 | 18-15 | 18-1455 |
| E | 16-590 | 16-655 | 16-730 | 16-795 | 18-130 | 18-1465 |
| F | 14-1310 | 14-1300 | 14-1285 | 14-1260 | 14-1100 | 14-1030 |
| G | 14-1480 | 14-1450 | 14-1410 | 14-1365 | 14-1170 | 14-1070 |
| H | 14-1420 | 14-1470 | 14-1530 | 14-1580 | 16-640 | 16-1715 |
| 15 | 14-880 | 14-995 | 14-1120 | 14-1235 | 14-1385 | 14-1530 |
| 16 | 16-380 | 16-500 | 16-620 | 16-740 | 16-755 | 16-795 |
| 17 | 16-815 | 16-930 | 16-1055 | 16-1170 | 16-1215 | 16-1260 |
| 18 | 16-420 | 16-510 | 16-610 | 16-705 | 16-865 | 16-1830 |
| 19 | 14-1625 | 14-1670 | 14-1720 | 14-1760 | 14-6785 | 16-80 |
| 20 | 14-1930 | 16-10 | 16-90 | 16-155 | 16-240 | 16-800 |
| 21 | 16-320 | 16-430 | 16-540 | 16-635 | 16-620 | 16-925 |
| 22 | 14-1950 | 16-30 | 16-105 | 16-175 | 16-255 | 16-410 |
| 23 | 14-1890 | 14-1990 | 16-80 | 16-165 | 16-185 | 16-510 |
| 24 | 14-1520 | 14-1640 | 14-1760 | 14-1875 | 16-255 | 16-940 |
| 25 | 16-230 | 16-340 | 16-455 | 16-555 | 16-555 | 16-985 |
| 26 | 16-430 | 16-500 | 16-570 | 16-640 | 16-640 | 16-875 |
| 27 | 14-1690 | 14-1745 | 14-1805 | 14-1860 | 14-1890 | 16-590 |
| 28 | 14-1545 | 14-1640 | 14-1735 | 14-1825 | 16-850 | 16-1910 |

# APPENDIX B

## STRAIN LOAD VALUES

## TABLE IV

### Strain-Load Values

|  | Plate of Zero Nominal Deflection |  |  |  |  | Plate of 1/8" Nominal Deflection |  |  |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
|  | Load in Kips |  |  |  |  | Load in Kips |  |  |  |  |
| Gage Number | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 |
| 1 | 285 | 570 | 855 | 1135 | 1390 | 250 | 500 | 750 | 1000 | 1250 |
| 1 | 110 | 220 | 325 | 435 | 510 | 200 | 400 | 600 | 800 | 1000 |
| 1 | 192.5 | 395 | 590 | 785 | 950 | 225 | 450 | 675 | 900 | 1125 |
| 2 | 245 | 495 | 740 | 990 | 1185 | 240 | 480 | 720 | 960 | 1200 |
| 2 | 145 | 285 | 430 | 580 | 680 | 210 | 425 | 640 | 850 | 1065 |
| 2 | 195 | 390 | 585 | 785 | 932.5 | 225 | 452.5 | 680 | 905 | 1132.5 |
| 3 | 220 | 440 | 660 | 880 | 1095 | 250 | 500 | 755 | 1005 | 1260 |
| 3 | 185 | 370 | 550 | 735 | 920 | 225 | 450 | 670 | 895 | 1120 |
| 3 | 202.5 | 405 | 605 | 807.5 | 1007.5 | 237.5 | 475 | 712.5 | 950 | 1190 |
| 4 | 205 | 410 | 625 | 830 | 1035 | 250 | 495 | 745 | 990 | 1240 |
| 4 | 205 | 410 | 625 | 830 | 1035 | 235 | 470 | 710 | 945 | 1180 |
| 4 | 205 | 410 | 625 | 830 | 1035 | 242.5 | 492.5 | 727.5 | 967.5 | 1210 |
| 5 | 200 | 400 | 600 | 800 | 1000 | 270 | 545 | 815 | 1090 | 1360 |
| 5 | 215 | 425 | 640 | 850 | 1060 | 140 | 280 | 420 | 560 | 700 |
| 5 | 207.5 | 412.5 | 620 | 825 | 1030 | 205 | 412.5 | 617.5 | 825 | 1030 |
| 6 | 205 | 410 | 610 | 820 | 1020 | 325 | 655 | 985 | 1310 | 1640 |
| 6 | 240 | 480 | 720 | 960 | 1200 | 50 | 120 | 205 | 305 | 445 |
| 6 | 222.5 | 445 | 665 | 890 | 1110 | 187.5 | 387.5 | 595 | 807.5 | 1042.5 |
| 7 | 200 | 400 | 600 | 800 | 1000 | 370 | 730 | 1070 | 1390 | 1670 |
| 7 | 200 | 400 | 610 | 830 | 1040 | 35 | 95 | 200 | 330 | 480 |
| 7 | 200 | 400 | 605 | 815 | 1020 | 202.5 | 417.5 | 635 | 860 | 1075 |
| 8 | 180 | 390 | 620 | 855 | 1015 | 360 | 700 | 1035 | 1345 | 1630 |
| 8 | 180 | 365 | 555 | 760 | 980 | 20 | 80 | 175 | 310 | 480 |
| 8 | 180 | 377.5 | 587.5 | 807.5 | 997.5 | 190 | 390 | 605 | 827.5 | 1055 |
| 9 | 220 | 440 | 660 | 880 | 1100 | 350 | 690 | 1020 | 1335 | 1635 |
| 9 | 150 | 330 | 530 | 740 | 930 | - 20 | - 15 | + 50 | +100 | +260 |
| 9 | 185 | 385 | 595 | 810 | 1015 | 165 | 337.5 | 525 | 747.5 | 947.5 |
| 10 | 170 | 370 | 580 | 800 | 1030 | 375 | 740 | 1090 | 1420 | 1700 |
| 10 | 150 | 330 | 530 | 740 | 960 | 0 | 10 | 70 | 170 | 270 |
| 10 | 160 | 350 | 555 | 770 | 995 | 187.5 | 375 | 580 | 795 | 985 |
| 11 | 160 | 340 | 540 | 740 | 950 | 370 | 720 | 1060 | 1375 | 1700 |
| 11 | 175 | 370 | 580 | 790 | 1005 | 50 | 70 | 155 | 275 | 420 |
| 11 | 167.5 | 355 | 500 | 765 | 977.5 | 210 | 395 | 607.5 | 825 | 1060 |
| 12 | 150 | 405 | 570 | 760 | 1000 | 330 | 660 | 970 | 1270 | 1560 |
| 12 | 200 | 505 | 720 | 950 | 1220 | 30 | 100 | 200 | 320 | 400 |
| 12 | 195 | 405 | 645 | 855 | 1110 | 180 | 380 | 585 | 795 | 1010 |

Strains in Micro-Inch Per Inch
F indicates gage on front face
B indicates gage on back face
m indicates mean value

## TABLE IV (Cont.)

| Gage Number | Plate of Zero Nominal Deflection | | | | | Plate of 1/8" Nominal Deflection | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Load in Kips | | | | | Load in Kips | | | | |
| | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 |
| 13 | 155 | 315 | 475 | 650 | 830 | 270 | 530 | 780 | 1020 | 1250 |
| 13 | 220 | 430 | 645 | 860 | 1080 | 130 | 275 | 415 | 560 | 710 |
| 13 | 187.5 | 372.5 | 560 | 755 | 955 | 200 | 402.5 | 597.5 | 790 | 980 |
| 14 | 180 | 360 | 540 | 720 | 900 | 245 | 490 | 720 | 945 | 1150 |
| 14 | 190 | 380 | 560 | 745 | 920 | 225 | 445 | 660 | 860 | 1050 |
| 14 | 185 | 370 | 550 | 732.5 | 910 | 235 | 467.5 | 690 | 902.5 | 1100 |
| 15 | 205 | 410 | 620 | 825 | 1030 | 255 | 510 | 750 | 980 | 1180 |
| 15 | 165 | 335 | 500 | 670 | 835 | 230 | 460 | 685 | 900 | 1100 |
| 15 | 185 | 372.5 | 560 | 747.5 | 932.5 | 242.5 | 485 | 717.5 | 940 | 1140 |
| 16 | 255 | 500 | 745 | 980 | 1210 | 295 | 555 | 800 | 1030 | 1260 |
| 16 | 145 | 285 | 430 | 580 | 680 | 230 | 450 | 650 | 850 | 1050 |
| 16 | 200 | 392.5 | 587.5 | 780 | 945 | 262.5 | 502.5 | 725 | 940 | 1155 |
| 17 | 270 | 540 | 810 | 1080 | 1360 | 265 | 520 | 775 | 1020 | 1265 |
| 17 | 95 | 200 | 320 | 440 | 565 | 190 | 380 | 560 | 720 | 930 |
| 17 | 182.5 | 370 | 565 | 760 | 962.5 | 227.5 | 450 | 662.5 | 870 | 1097 |
| 18F | 205 | 410 | 615 | 820 | 1150 | 240 | 485 | 730 | 970 | 1210 |
| 18B | 205 | 415 | 625 | 830 | 1200 | 200 | 405 | 610 | 810 | 1010 |
| 18M | 205 | 412.5 | 620 | 825 | 1175 | 220 | 445 | 670 | 890 | 1110 |
| 19F | 200 | 400 | 600 | 805 | 1050 | 230 | 460 | 690 | 925 | 1160 |
| 19B | 200 | 400 | 600 | 805 | 1080 | 110 | 225 | 340 | 450 | 530 |
| 19M | 200 | 400 | 600 | 805 | 1065 | 170 | 342.5 | 505 | 687.5 | 845 |
| 20F | 200 | 400 | 600 | 800 | 1000 | 250 | 500 | 755 | 1010 | 1260 |
| 20B | 210 | 420 | 630 | 840 | 1050 | 115 | 235 | 350 | 470 | 590 |
| 20M | 205 | 410 | 615 | 820 | 1025 | 182.5 | 367.5 | 552.5 | 740 | 925 |
| 21F | 220 | 440 | 655 | 870 | 1090 | 240 | 485 | 730 | 970 | 1220 |
| 21B | 195 | 395 | 595 | 790 | 990 | 170 | 340 | 520 | 690 | 870 |
| 21M | 207.5 | 417.5 | 625 | 830 | 1040 | 205 | 412.5 | 625 | 830 | 1045 |
| 22F | 180 | 360 | 545 | 730 | 910 | 245 | 490 | 735 | 980 | 1230 |
| 22B | 225 | 450 | 680 | 905 | 1130 | 150 | 310 | 465 | 620 | 780 |
| 22M | 202.5 | 405 | 612.5 | 817.5 | 1020 | 197.5 | 400 | 600 | 800 | 1005 |
| 23F | 185 | 370 | 550 | 740 | 925 | 260 | 520 | 790 | 1060 | 1320 |
| 23B | 220 | 440 | 660 | 880 | 1105 | 110 | 225 | 340 | 450 | 660 |
| 23M | 202.5 | 405 | 605 | 810 | 1015 | 185 | 372.5 | 565 | 755 | 990 |
| 24F | 190 | 390 | 580 | 775 | 870 | 270 | 545 | 820 | 1090 | 1570 |
| 24B | 225 | 450 | 675 | 900 | 1120 | 105 | 220 | 330 | 440 | 520 |
| 24M | 207.5 | 420 | 627.5 | 837.5 | 1045 | 187.5 | 382.5 | 575 | 765 | 1045 |
| 25F | 165 | 335 | 500 | 665 | 900 | 240 | 480 | 725 | 960 | 1210 |
| 25B | 195 | 390 | 600 | 830 | 1140 | 170 | 340 | 520 | 690 | 870 |
| 25M | 180 | 362.5 | 550 | 747.5 | 1020 | 205 | 410 | 622.5 | 825 | 1040 |

Strains in Micro-Inch Per inch
F indicates gage on front face
B indicates gage on back face
M indicates mean value

## TABLE IV (Cont.)

| | Plate of Zero Nominal Deflection | | | | | Plate of 1/8" Nominal Deflection | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Load in Kips | | | | | Load in Kips | | | | |
| Gage Number | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 |
| 26F | 190 | 380 | 570 | 760 | 955 | 215 | 430 | 660 | 900 | 1135 |
| 26B | 180 | 370 | 560 | 750 | 940 | 130 | 200 | 390 | 520 | 650 |
| 26M | 185 | 375 | 565 | 755 | 947.5 | 172.5 | 345 | 525 | 760 | 892.5 |
| 27F | 195 | 390 | 585 | 780 | 1080 | 250 | 510 | 765 | 1020 | 1275 |
| 27B | 165 | 335 | 510 | 690 | 1000 | 115 | 230 | 350 | 570 | 680 |
| 27M | 180 | 362.5 | 547.5 | 735 | 1040 | 182.5 | 370 | 557.5 | 795 | 977.5 |
| 28F | 190 | 380 | 575 | 765 | 1080 | 240 | 490 | 735 | 980 | 1220 |
| 28B | 165 | 335 | 510 | 685 | 990 | 200 | 400 | 605 | 810 | 1010 |
| 28M | 180 | 357.5 | 542.5 | 725 | 1035 | 220 | 445 | 670 | 895 | 1115 |
| A | 150 | 275 | 390 | 500 | 620 | 145 | 290 | 420 | 530 | 620 |
| D | 140 | 260 | 375 | 480 | 605 | 150 | 300 | 435 | 560 | 670 |
| -M | 145 | 267.5 | 382.5 | 490 | 612.5 | 147.5 | 295 | 427.5 | 545 | 645 |
| B | -15 | -35 | -60 | -95 | -145 | -10 | -20 | -40 | -80 | -145 |
| C | -25 | -55 | -90 | -125 | -170 | -00 | 0 | 0 | -10 | - 75 |
| -M | -20 | -45 | -75 | -110 | -157.5 | - 5 | -10 | -20 | -45 | -110 |
| E | 80 | 165 | 250 | 335 | 415 | 150 | 285 | 415 | 530 | 620 |
| H | 100 | 200 | 300 | 400 | 500 | 140 | 270 | 395 | 505 | 595 |
| -M | 90 | 182.5 | 275 | 362.5 | 457.5 | 145 | 277.5 | 405 | 517.5 | 607.5 |
| F | -30 | -00 | -100 | -140 | 190 | +20 | +40 | +60 | +60 | 0 |
| G | -20 | -40 | -70 | -95 | 135 | + 5 | +10 | +10 | -10 | -60 |
| -M | -25 | -50 | -85 | 117.5 | 162.5 | 125 | 25 | 35 | 25 | -30 |

Strains in Micro-Inch Per Inch
F indicates gage on front face
B indicates gage on back face
M indicates mean value

## TABLE IV (Cont.)

## Strain Load Values

| | Plate of 3/16" Nominal Deflection | | | | | Plate of 1/4" Nominal Deflection | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Load in Kips | | | | | Load in Kips | | | | |
| Gage Number | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 |
| 1F | 215 | 435 | 655 | 875 | 1115 | 225 | 415 | 600 | 785 | 1010 |
| 1B | 235 | 480 | 720 | 960 | 1220 | 255 | 500 | 720 | 940 | 1200 |
| 1M | 225 | 457.5 | 687.5 | 917.5 | 1167.5 | 240 | 457.5 | 660 | 862.5 | 1105 |
| 2F | 230 | 450 | 675 | 900 | 1035 | 240 | 475 | 705 | 915 | 1065 |
| 2B | 250 | 490 | 735 | 975 | 1125 | 240 | 475 | 705 | 915 | 1055 |
| 2M | 240 | 470 | 705 | 932.5 | 1080 | 240 | 475 | 705 | 915 | 1060 |
| 3F | 250 | 500 | 750 | 1000 | 1140 | 250 | 490 | 725 | 935 | 1110 |
| 3B | 240 | 480 | 720 | 965 | 1130 | 265 | 510 | 730 | 935 | 1090 |
| 3M | 245 | 490 | 735 | 982.5 | 1135 | 257.5 | 500 | 727.5 | 935 | 1100 |
| 4F | 270 | 540 | 810 | 1080 | 1390 | 310 | 600 | 865 | 1115 | 1810 |
| 4B | 240 | 470 | 710 | 950 | 1230 | 250 | 490 | 720 | 930 | 1500 |
| 4M | 255 | 505 | 760 | 1015 | 1310 | 280 | 545 | 792.5 | 1022.5 | 1685 |
| 5F | 305 | 610 | 925 | 1230 | 1420 | 410 | 810 | 1175 | 1510 | 1820 |
| 5B | 75 | 150 | 225 | 310 | 600 | 20 | 45 | 95 | 165 | 310 |
| 5M | 190 | 380 | 575 | 770 | 1010 | 215 | 427.5 | 635 | 837.5 | 1065 |
| 6F | 400 | 810 | 1220 | 1620 | 1740 | 600 | 1100 | 1580 | 2000 | 2700 |
| 6B | -70 | -115 | -110 | -90 | +100 | -200 | -320 | -380 | -390 | - 90 |
| 6M | 165 | 347.5 | 555 | 765 | 920 | 200 | 390 | 600 | 805 | 1305 |
| 7F | 470 | 935 | 1400 | 1800 | 1960 | 560 | 1070 | 1540 | 1970 | 2570 |
| 7B | -140 | -245 | -315 | 330 | -125 | -220 | -360 | -440 | -460 | -270 |
| 7M | 165 | 345 | 542.5 | 735 | 917.5 | 170 | 355 | 550 | 755 | 1150 |
| 8F | 450 | 885 | 1290 | 1660 | 1760 | 520 | 990 | 1440 | 1860 | 2200 |
| 8B | -160 | -270 | -320 | -300 | -155 | -300 | -530 | -690 | -800 | -550 |
| 8M | 145 | 307.5 | 485 | 680 | 802.5 | 110 | 230 | 375 | 530 | 825 |
| 9F | 440 | 860 | 1260 | 1640 | 1710 | 600 | 1100 | 1580 | 2250 | 2430 |
| 9B | -90 | -165 | -210 | -195 | + 60 | -280 | -480 | -620 | -700 | -500 |
| 9M | 175 | 347.5 | 525 | 722.5 | 885 | 160 | 310 | 480 | 775 | 960 |
| 10F | 620 | 1120 | 1560 | 1980 | 2390 | 560 | 1080 | 1560 | 2040 | 2410 |
| 10B | -110 | -180 | -200 | -140 | +200 | -300 | -520 | -690 | -790 | -500 |
| 10M | 260 | 470 | 680 | 920 | 1295 | 130 | 280 | 435 | 625 | 925 |
| 11F | 490 | 950 | 1380 | 1760 | 1830 | 580 | 1100 | 1600 | 2090 | 2400 |
| 11B | -130 | -220 | -250 | -220 | - 10 | -280 | -530 | -700 | -810 | -480 |
| 11M | 180 | 365 | 565 | 770 | 910 | 150 | 285 | 450 | 640 | 960 |
| 12F | 450 | 990 | 1300 | 1690 | 1660 | 520 | 1000 | 1460 | 1990 | 2160 |
| 12B | -35 | -50 | -45 | +10 | +230 | -220 | -390 | -510 | -600 | -100 |
| 12M | 207.5 | 470 | 677.5 | 850 | 945 | 150 | 305 | 475 | 695 | 1030 |

Strain Micro-Inch Per Inch
F indicates gage on front face
B indicates gage on back face
M indicates mean value

# TABLE IV (Cont.)

## Strain Load Values

| Gage Number | Plate of 3/16" Nominal Deflection<br>Load in Kips | | | | | Plate of 1/4" Nominal Deflection<br>Load in Kips | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 |
| 13F | 330 | 660 | 1000 | 1330 | 1700 | 440 | 840 | 1190 | 1560 | 2710 |
| 13B | 85 | 180 | 280 | 400 | 730 | -20 | -40 | -40 | -20 | 200 |
| 13M | 207.5 | 420 | 640 | 865 | 1215 | 210 | 400 | 575 | 770 | 1455 |
| 14F | 275 | 550 | 830 | 1105 | 1500 | 350 | 560 | 950 | 1230 | 2600 |
| 14B | 265 | 510 | 720 | 990 | 1300 | 260 | 510 | 740 | 960 | 3160 |
| 14M | 270 | 530 | 775 | 1047.5 | 1400 | 305 | 585 | 845 | 1095 | 2880 |
| 15F | 290 | 550 | 780 | 1000 | 1900 | 285 | 545 | 795 | 1035 | 1200 |
| 15B | 260 | 515 | 760 | 1005 | 1845 | 285 | 545 | 795 | 1040 | 1300 |
| 15M | 275 | 532.5 | 770 | 1002.5 | 1872.5 | 285 | 545 | 795 | 1037.5 | 1250 |
| 16F | 290 | 560 | 790 | 1010 | 1310 | 240 | 480 | 710 | 920 | 990 |
| 16B | 275 | 530 | 760 | 970 | 1265 | 280 | 560 | 830 | 1075 | 1210 |
| 16M | 282.5 | 545 | 775 | 990 | 1287.5 | 240 | 520 | 770 | 997.5 | 1100 |
| 17F | 235 | 470 | 705 | 940 | 1160 | 200 | 400 | 600 | 800 | 860 |
| 17B | 235 | 470 | 705 | 940 | 1180 | 290 | 565 | 830 | 1070 | 1230 |
| 17M | 235 | 470 | 705 | 940 | 1170 | 245 | 482.5 | 715 | 935 | 1045 |
| 18F | 285 | 570 | 855 | 1140 | 1450 | 300 | 570 | 815 | 1050 | 1405 |
| 18B | 215 | 430 | 650 | 860 | 1080 | 230 | 445 | 650 | 840 | 1065 |
| 18M | 250 | 500 | 752.5 | 1000 | 1265 | 265 | 507.5 | 732.5 | 945 | 1235 |
| 19F | 220 | 440 | 665 | 890 | 1340 | 260 | 505 | 730 | 960 | 1380 |
| 19B | 100 | 205 | 310 | 405 | 275 | 100 | 195 | 290 | 380 | 450 |
| 19M | 160 | 322.5 | 487.5 | 647.5 | 807.5 | 180 | 350 | 510 | 670 | 915 |
| 20F | 185 | 370 | 560 | 740 | 950 | 150 | 305 | 460 | 620 | 960 |
| 20B | 125 | 260 | 385 | 520 | 705 | 160 | 325 | 485 | 650 | 880 |
| 20M | 155 | 315 | 472.5 | 630 | 827.5 | 155 | 315 | 472.5 | 635 | 920 |
| 21F | 120 | 245 | 370 | 495 | 700 | 70 | 150 | 255 | 390 | 630 |
| 21B | 240 | 480 | 720 | 950 | 1160 | 220 | 440 | 670 | 880 | 960 |
| 21M | 180 | 362.5 | 545 | 722.5 | 930 | 145 | 295 | 462.5 | 635 | 795 |
| 22F | 160 | 320 | 490 | 685 | 1050 | 80 | 165 | 285 | 445 | 710 |
| 22B | 140 | 300 | 490 | 630 | 800 | 160 | 320 | 480 | 640 | 820 |
| 22M | 150 | 310 | 490 | 657.5 | 925 | 120 | 242.5 | 382.5 | 542.5 | 765 |
| 23F | 150 | 295 | 450 | 630 | 1000 | 40 | 120 | 225 | 365 | 645 |
| 23B | 205 | 410 | 600 | 735 | 830 | 190 | 390 | 580 | 770 | 880 |
| 23M | 177.5 | 352.5 | 525 | 682.5 | 915 | 115 | 255 | 402.5 | 567.5 | 762.5 |
| 24F | 170 | 335 | 505 | 685 | 990 | 250 | 485 | 720 | 960 | 1450 |
| 24B | 240 | 480 | 720 | 920 | 1170 | 30 | 65 | 130 | 235 | 450 |
| 24M | 205 | 407.5 | 612.5 | 802.5 | 1080 | 140 | 275 | 425 | 597.5 | 950 |
| 25F | 80 | 175 | 285 | 440 | 690 | -20 | -25 | 0 | 60 | 290 |
| 25B | 300 | 585 | 860 | 1095 | 1330 | 220 | 440 | 660 | 880 | 100.0 |
| 25M | 190 | 380 | 572.5 | 767.5 | 1010 | 100 | 207.5 | 330 | 470 | 645 |

Strain in Micro Inch Per Inch
F indicates gage on front face
B indicates gage on back face
M indicates mean value

## TABLE IV (Cont.)

## Strain Load Values

| Gage Number | Plate of 3/16" Nominal Deflection | | | | | Plate of 1/4" Nominal Deflection | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Load in Kips | | | | | Load in Kips | | | | |
| | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 |
| 26F | 170 | 345 | 515 | 700 | 975 | 160 | 220 | 320 | 450 | 780 |
| 26B | 230 | 460 | 700 | 820 | 970 | 140 | 280 | 420 | 560 | 645 |
| 26M | 200 | 402.5 | 607.5 | 760 | 972.5 | 125 | 250 | 370 | 505 | 717.5 |
| 27F | 245 | 500 | 770 | 1060 | 1550 | 220 | 430 | 625 | 815 | 1860 |
| 27B | 170 | 330 | 500 | 600 | 570 | 120 | 235 | 340 | 450 | 540 |
| 27M | 207.5 | 415 | 635 | 830 | 1060 | 170 | 332.5 | 482.5 | 632.5 | 1200 |
| 28F | 310 | 590 | 850 | 1080 | 1310 | 260 | 500 | 730 | 950 | 2340 |
| 28B | 235 | 450 | 640 | 810 | 950 | 200 | 390 | 590 | 780 | 20.00 |
| 28M | 272.5 | 520 | 745 | 945 | 1130 | 230 | 445 | 660 | 865 | 2170 |
| A | 140 | 275 | 400 | 510 | 730 | 120 | 230 | 350 | 460 | 800 |
| D | 170 | 340 | 490 | 630 | 910 | 140 | 280 | 410 | 540 | 890 |
| - | 155 | 307.5 | 445 | 570 | 820 | 130 | 255 | 380 | 500 | 845 |
| B | -50 | -90 | -135 | -190 | -315 | -100 | -180 | -225 | -275 | -385 |
| C | - 5 | - 5 | -10 | -25 | -100 | - 55 | -75 | -100 | -115 | -190 |
| - | -27.5 | -47.5 | -72.5 | -107.5 | -207.5 | -77.5 | -127.5 | -162.5 | -195 | -287.5 |
| E | 170 | 350 | 485 | 600 | 980 | 160 | 320 | 470 | 605 | 2005 |
| H | 115 | 230 | 340 | 455 | 710 | 110 | 225 | 335 | 445 | 1540 |
| - | 142.5 | 290 | 412.5 | 527.5 | 845 | 135 | 272.5 | 402.5 | 525 | 1772.5 |
| F | +10 | +10 | + 5 | -25 | -90 | -55 | -95 | -130 | -160 | -340 |
| G | -70 | -125 | -180 | -245 | -370 | -75 | -230 | -315 | -375 | -615 |
| - | -30 | -57.5 | -85 | -135 | -230 | -65 | -162.5 | -222.5 | -267.5 | -477.5 |

Strain in Micro Inch Per Inch
F indicates gage on front face
B indicates gage on back face
M indicates mean value

## APPENDIX C

## AVERAGE INITIAL DEFLECTION AND AVERAGE STRAIN CALCULATIONS

## TABLE V

### Calculation of the [illegible] Deflection

Plate of Low Nominal Deflection

| Upper Edge | Lower Edge | Center |
|---|---|---|
| -6 | -47 | -26 |
| -5 | -5[illegible] | -7 |
| +1 | -64 | -25 |
| -3 | -55 | -15 |
| -6 | -5[illegible] | -[illegible] |
| -7 | -53 | -[illegible] |
| -[illegible] | -37 | -23 |
| -[illegible] | -27 | -6 |
| -2 | -26 | +5 |
| 3 | -24 | +6 |
| +7 | -[illegible] | +1 |
| -40 | -478 | -157 |
|  | - 40 | +[illegible] |
|  | -518 | +102 |
| Average | -259 |  |

= 0.0093"
= 0.175"
= 0.2745

Plate of [illegible]" Nominal Deflection

| Upper Edge | Lower Edge | Center |
|---|---|---|
| -9 | -16 | 74 |
| -12 | -24 | 72 |
| -13 | -16 | 78 |
| -10 | -16 | 77 |
| -13 | -11 | [illegible] |
| -11 | -17 | [illegible] |
| -8 | -9 | [illegible] |
| -2 | +7 | [illegible] |
| +9 | +12 | [illegible] |
| +6 | +10 | [illegible] |
| +[illegible] | +5 | [illegible] |
| -51 | -65 | +8[illegible]7 |
|  | -51 | + 37 |
|  | -116 | +8[illegible] |
|  | - 57 |  |

= [illegible]
= [illegible]"
= [illegible]

Plate of 3/16" Nominal Deflection

| Upper Edge | Lower Edge | Center |
|---|---|---|
| 10 | -33 | 135 |
| 12 | -46 | 138 |
| 22 | -50 | 141 |
| 32 | -56 | 143 |
| 31 | -64 | 149 |
| 33 | -66 | 1[illegible]9 |
| 30 | -68 | 132 |
| 28 | -65 | 131 |
| 17 | -54 | 133 |
| 14 | -5[illegible] | 1[illegible] |
| 6 | -[illegible] | 1[illegible] |
| +274 | -6[illegible]5 | +1490 |
|  | +274 | + 167 |
|  | -331 | +1657 |
| Average | -167 |  |

= 0.2536"
= 0.[illegible]"
= 0.205

Plate of 1/4" Nominal Deflection

| Upper Edge | Center | Lower Edge |
|---|---|---|
| -46 | 240 | -57 |
| -59 | 246 | -[illegible] |
| -6[illegible] | 270 | -47 |
| -7[illegible] | 2[illegible] | -[illegible] |
| -71 | 290 | -[illegible] |
| -63 | 265 | -[illegible] |
| -48 | [illegible] | -[illegible] |
| -1[illegible] | [illegible] | -15 |
| -33 | [illegible] | -[illegible] |
| -26 | [illegible] | -[illegible] |
| -12 | [illegible] | -[illegible] |
| -500 | +2657 | -306 |
|  | + 798 | -[illegible] |
|  | +2451 | -[illegible] |
|  |  | -3[illegible] |

= [illegible]
= [illegible]
= 1.[illegible]

# TABLE VI

## Calculation of the Mean Strain

| | Plate of Zero Nominal Deflection | | | | | Plate of 3/16" Nominal Deflection | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Load(Kips) | 20 | 40 | 60 | 80 | 100 | 20 | 40 | 60 | 80 | 100 |
| | Strain (Micro-inch Per Inch) | | | | | Strain (Micro-inch Per Inch) | | | | |
| | 9.0 | 20.0 | 29.5 | 39.3 | 47.8 | 11 | 22.5 | 34 | 45.6 | 59.9 |
| | 9.7 | 20.0 | 30.0 | 40.0 | 49.0 | 12.2 | 24.0 | 36.2 | 48.3 | 55.9 |
| | 10.1 | 20.4 | 31.2 | 41.3 | 51.7 | 12.0 | 24.0 | 36.0 | 48.2 | 62.2 |
| | 10.2 | 21.7 | 32.7 | 43.3 | 54.0 | 8.7 | 17.8 | 28.0 | 38.2 | 47.2 |
| | 10.0 | 20.0 | 30.0 | 41.0 | 51.0 | 8.3 | 17.2 | 27.0 | 36.8 | 46.0 |
| | 9.0 | 18.8 | 29.4 | 30.2 | 49.8 | 7.4 | 15.5 | 24.2 | 34.0 | 40.2 |
| | 9.5 | 19.0 | 29.8 | 40.5 | 50.8 | 8.8 | 17.3 | 26.3 | 36.1 | 44.0 |
| | 8.0 | 17.5 | 28.0 | 38.3 | 49.6 | 13.0 | 23.4 | 34.0 | 46.0 | 64.8 |
| | 8.2 | 18.0 | 28.0 | 38.0 | 48.0 | 9.1 | 18.4 | 28.2 | 38.5 | 45.3 |
| | 9.0 | 19.4 | 30.3 | 40.3 | 51.8 | 10.3 | 22.6 | 33.2 | 42.7 | 51.5 |
| | 9.2 | 18.5 | 27.5 | 36.7 | 45.6 | 13.0 | 25.8 | 38.0 | 50.0 | 70.0 |
| | 9.5 | 19.0 | 28.5 | 38.0 | 46.7 | 14.0 | 26.9 | 38.7 | 49.8 | 65.3 |
| | 8.8 | 18.0 | 28.0 | 37.7 | 48.5 | 10.5 | 21.6 | 33.5 | 45.9 | 56.1 |
| Sum | 120.2 | 250.3 | 392.9 | 504.6 | 639.3 | 138.3 | 277.0 | 417.3 | 570.1 | 708.4 |
| Mean Value | 185 | 384.5 | 604.8 | 775 | 982.5 | 212.8 | 426 | 642 | 876 | 1090 |

| | Plate of 1/8" Nominal Deflection | | | | | Plate of 1/4" Nominal Deflection | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Strain (Micro-inch Per Inch) | | | | | Strain (Micro-inch Per Inch) | | | | |
| | 11.1 | 22.3 | 33.7 | 45.0 | 56.0 | 12.0 | 22.4 | 32.2 | 42.1 | 56.1 |
| | 11.6 | 23.3 | 35.0 | 47.0 | 58.5 | 12.5 | 24.6 | 36.0 | 46.4 | 54.3 |
| | 11.8 | 23.9 | 35.3 | 47.0 | 58.7 | 13.6 | 26.3 | 38.3 | 49.8 | 79.1 |
| | 9.8 | 19.8 | 30.0 | 40.8 | 51.9 | 10.2 | 20.0 | 30.6 | 40.8 | 61.5 |
| | 10.0 | 21.0 | 31.8 | 42.8 | 53.7 | 8.4 | 18.0 | 27.2 | 37.7 | 57.3 |
| | 9.5 | 19.5 | 30.2 | 41.5 | 53.0 | 5.5 | 11.6 | 18.8 | 26.6 | 41.1 |
| | 8.0 | 16.8 | 26.2 | 37.2 | 47.3 | 7.8 | 15.2 | 23.7 | 37.3 | 47.8 |
| | 9.2 | 18.7 | 29.0 | 39.7 | 49.2 | 6.7 | 14.0 | 21.9 | 31.3 | 46.2 |
| | 10.5 | 19.7 | 30.2 | 41.2 | 53.0 | 7.5 | 14.3 | 22.5 | 32.0 | 48.0 |
| | 9.5 | 19.5 | 29.5 | 39.5 | 49.5 | 8.5 | 17.0 | 25.4 | 36.0 | 58.5 |
| | 11.4 | 23.0 | 34.0 | 44.3 | 54.0 | 14.7 | 28.0 | 40.6 | 53.0 | 129.0 |
| | 12.4 | 24.5 | 36.0 | 47.0 | 57.2 | 13.3 | 26.7 | 39.1 | 41.0 | 60.8 |
| Sum | 135.0 | 273.0 | 412.4 | 554.5 | 694.8 | 133.1 | 261.4 | 390.5 | 529.0 | 788.7 |
| Mean Value | 207.7 | 420 | 633 | 851 | 1069 | 204.8 | 402 | 601 | 813 | 1212 |

# TABLE VII

## Calculation of the Average Maximum Strain

### Front Face

| Load (Kips) | Gage Number | NOMINAL DEFLECTION | | | |
|---|---|---|---|---|---|
| | | 0 | 1/8 | 3/16 | 1/4 |
| 20 | 7 | 200 | 370 | 470 | 560 |
| | 11 | 160 | 370 | 490 | 580 |
| | Average | 180 | 370 | 480 | 570 |
| | Ratio | 0.973 | 1.782 | 2.255 | 2.78 |
| 40 | 7 | 400 | 730 | 935 | 1070 |
| | 11 | 340 | 720 | 950 | 1100 |
| | Average | 370 | 725 | 942.5 | 1085 |
| | Ratio | 0.962 | 1.728 | 2.215 | 2.70 |
| 60 | 7 | 600 | 1070 | 1400 | 1540 |
| | 11 | 540 | 1060 | 1380 | 1000 |
| | Average | 570 | 1065 | 1390 | 1570 |
| | Ratio | 0.945 | 1.684 | 2.165 | 2.615 |
| 80 | 7 | 800 | 1390 | 1800 | 1970 |
| | 11 | 740 | 1375 | 1760 | 2090 |
| | Average | 770 | 1382.5 | 1780 | 2030 |
| | Ratio | 0.933 | 1.626 | 2.030 | 2.498 |
| 100 | 7 | 1000 | 1670 | 1960 | 2570 |
| | 11 | 950 | 1700 | 1830 | 2400 |
| | Average | 975 | 1685 | 1925 | 2485 |
| | Ratio | 0.993 | 1.578 | 1.766 | 2.050 |

## TABLE VII (Cont.)

## Calculation of the Average Minimum Strain

### Back Face

| Load | Gage | NOMINAL DEFLECTION | | | |
|---|---|---|---|---|---|
| (Kips) | Number | 0" | 1/8" | 3/16" | 1/4" |
| 20 | 8 | 180 | 20 | -160 | - 300 |
| | 9 | 150 | -20 | - 90 | - 280 |
| | 10 | 150 | 0 | -110 | - 300 |
| | Average | 160 | 0 | -120 | - 293.3 |
| | Ratio | 0.865 | 0 | -0.564 | -1.430 |
| 40 | 8 | 365 | 80 | -270 | - 530 |
| | 9 | 330 | -15 | -165 | - 480 |
| | 10 | 330 | 10 | -180 | - 520 |
| | Average | 341.6 | 25 | -205 | - 510 |
| | Ratio | 0.888 | 0.059 | -0.481 | -1.269 |
| 60 | 8 | 555 | 175 | -320 | - 690 |
| | 9 | 530 | 50 | -210 | - 620 |
| | 10 | 530 | 70 | -200 | - 690 |
| | Average | 538.3 | 98.3 | -243.3 | - 666.6 |
| | Ratio | 0.891 | 0.155 | -0.379 | -1.109 |
| 80 | 8 | 760 | 310 | -300 | - 800 |
| | 9 | 740 | 160 | -195 | - 700 |
| | 10 | 740 | 170 | -140 | - 790 |
| | Average | 746.6 | 213.3 | -211.6 | - 763.3 |
| | Ratio | 0.964 | 0.250 | -0.241 | -0.949 |
| 100 | 8 | 980 | 480 | -155 | - 550 |
| | 9 | 930 | 260 | + 60 | - 510 |
| | 10 | 960 | 270 | +300 | - 560 |
| | Average | 956.6 | 336.0 | + 35 | - 540 |
| | Ratio | 0.975 | 0.315 | 0.032 | -0.445 |

## TABLE VII (Cont.)

## Calculation of the Average Maximum Strain

## Middle Depth

| Load (Kips) | Gage Number | NOMINAL DEFLECTION | | | |
|---|---|---|---|---|---|
| | | 0" | 1/8" | 3/16" | 1/4" |
| 20 | 4 | 205 | 242.5 | 255 | 280 |
| | 14 | 185 | 235 | 270 | 305 |
| | Average | 195 | 238.7 | 262.5 | 292.5 |
| | Ratio | 1.055 | 1.150 | 1.232 | 1.429 |
| 40 | 4 | 410 | 492.5 | 505 | 545 |
| | 14 | 370 | 467.5 | 530 | 585 |
| | Average | 390 | 480.0 | 517.5 | 565 |
| | Ratio | 1.013 | 1.143 | 1.215 | 1.406 |
| 60 | 4 | 625 | 727.5 | 760 | 792.5 |
| | 14 | 550 | 690.0 | 775 | 845.0 |
| | Average | 587.5 | 708.7 | 767.5 | 818.7 |
| | Ratio | 0.972 | 1.120 | 1.196 | 1.361 |
| 80 | 4 | 830 | 967.5 | 1015 | 1022.5 |
| | 14 | 732.5 | 902.5 | 1047.5 | 1995.0 |
| | Average | 781.2 | 935.0 | 1031.2 | 1508.7 |
| | Ratio | 1.009 | 1.100 | 1.179 | 1.855 |
| 100 | 4 | 1035 | 1210 | 1310 | 1685 |
| | 14 | 910 | 1100 | 1400 | 2880 |
| | Average | 972.5 | 1155 | 1355 | 2282 |
| | Ratio | 0.990 | 1.081 | 1.242 | 1.886 |

# APPENDIX D

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## MEASURED AND CALCULATED APPLIED LOAD

| | | | | |
|---|---|---|---|---|
| Nominal Deflection | 0 | 1/8" | 3/16" | 1/4" |
| Average Strain in the Plate (micro-in/in) | 604.8 | 642.0 | 633.3 | 601.1 |
| Product Strain-Cross Sectional Plate Area | 1814.4 | 1926.0 | 1899.0 | 1803.0 |
| Maximum Strain in Stiffeners | 700 | 720 | 800 | 750 |
| | 520 | 650 | 750 | 820 |
| Minimum Strain in Stiffeners | -260 | -200 | -270 | -375 |
| | -235 | -120 | -300 | -475 |
| Average Strain in the Stiffeners | 181.3 | 262.5 | 245.0 | 180.0 |
| Product Strain Cross-Sectional Stiffeners Area | 226.6 | 328.0 | 306.0 | 225.0 |
| Sum of Products Strain-Area | 2041.0 | 2254.0 | 2205.0 | 2028.0 |
| Calculated Applied Load (pounds) | 59200 | 65400 | 64000 | 58900 |
| Measured Load | 60000 | 60000 | 60000 | 60000 |
| Difference (pounds) | -800 | +5400 | +4000 | -1100 |
| Difference (percentage) | -1.3% | +9% | +6.7% | -1.8% |

## APPENDIX E

## REFERENCES

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Freire Duenas

The effect of initial deflection on the stress distribution in a panel of plating of a ship under tensile load.

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